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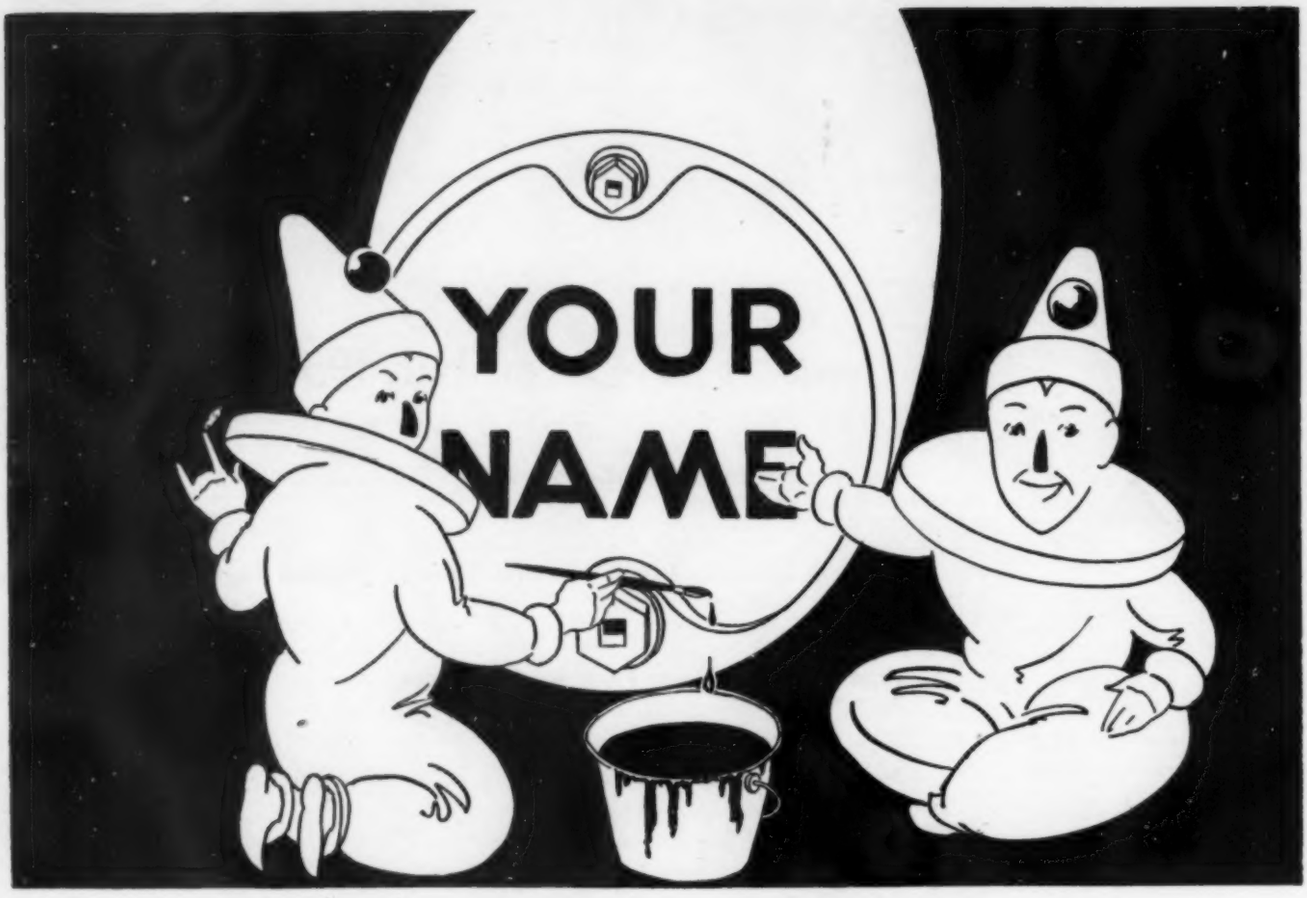

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VOLUME 37

CHEMICAL & METALLURGICAL ENGINEERING

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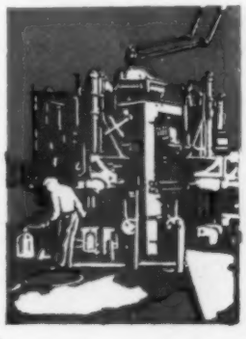
S. D. KIRKPATRICK, *Editor*

December, 1930

The Long Look Ahead

MUCH that has been written recently about overproduction leaves the reader with a confused and discouraged view of this extremely serious problem. Too much attention is being given to the present situation, too little attention to its cause, and almost none to the means available for relief and prevention. Stuart Chase, in his remarkable article in *Harper's,* gives a fearful picture of a ruthless economic giant, long since grown beyond control, and now threatening to overthrow our whole business system. The only weapon Mr. Chase proposes—a governmental commission such as a state planning board—seems by contrast to be weak, if not entirely futile. Scoville Hamlin, editor of an unusual book entitled "The Menace of Overproduction," brings together authoritative chapters on many of the industries most severely affected, among them coal, oil, textiles and rayon, and also touches on the broader aspects of the problem in chapters on management, business organization, and finance. Then in a brief summary of the evidence as to the cause and extent, the editor singles out the constructive proposals to which we may look for the cure. Through them all is a common plea for balancing the forces of production and consumption, but back of each is the necessity for a definite plan of action.

THIS PLANNING FUNCTION in industry is a field in which the technical man has a real opportunity, provided he can see beyond his technology to the broader economic problems of the business. Perhaps there are some who cannot. Not long ago the head of one chemical company is reported to have said that he feared his own company was becoming "over-engineered." Too often when his technical men had been raised to positions of major responsibility, they made costly mistakes because their enthusiasm for technical achievement had overbalanced their business judgment.



Were such a criticism generally applicable, it would be a severe indictment of chemists and engineers. Fortunately, we know it is not universally true, for there are technically trained executives of proved ability, who are in positions of controlling responsibility in nearly all of the large corporations in the chemical engineering field. That they have been successful is a matter of record.

WITH LEADERS so well equipped, and in industries responsive to well-directed influences, there is urgent need for better planning. If every firm in the chemical industry were to lay out a program, not merely for six months or a year ahead but for three or five years or longer, there would be no cause for discouragement in the unbalanced situation that exists today. Production, purchasing, research, and sales could be scheduled over the longer period on the basis of previous experience and the study of normal trends. Revision of plans and the adjustment of quotas would, of course, be necessary at regular intervals or as unforeseen conditions affected the business. Yet if there were always before us the long-term objective toward which we are working in a definite way, at a fixed rate, all business must ultimately be stabilized in growth and development.

IT IS NOT TOO EARLY for individual firms in the process industries to begin the formulation of such plans. Through trade associations and governmental or private agencies, the factual data and statistics are available that would serve as a foundation for more logical programs of industrial operations. The plan itself, and the means of its execution, must come from individual initiative and enterprise. The technical executive has a golden opportunity today to prove that he is something more than an able technologist.

EDITORIALS

DECEMBER, 1930

A Yardstick For Color Valuation

FOR YEARS the only means of describing color was by the use of words. This method obviously is futile when it is realized that the number of colors distinguishable by visual observation of anyone with average eyesight is more than 6,000. In more recent years the problem of color definition has been partially solved by the use of physical standards, but this system has its weaknesses. It is impossible to prepare a complete set of physical standards, and even if it were there would be no assurance that the different colors would remain constant for any extended period. And a further complication is the variability of the human eye.

Development of the photo-electric cell and its adaptation to suitable instruments has at last supplied a yardstick for color valuation. The electronic tube has transferred the measurement of color from an unreliable to a scientific basis permitting specifications that will not only be definite but readily reproducible.

Dye works, paint and varnish factories, pulp and paper mills, oil refineries—in fact all process industries in which color plays a vital rôle—now face the prospect of an immediate revolution in their specifications. Rather than wait for the demand that is sure to come from the customer, production management in these plants may well take the initiative in revising and modernizing color measurements and standards.

Congressional Legislation and the Chemical Engineering Industries

EVERY INDIVIDUAL and every corporation in the United States has a genuine interest in the action of Congress during the present winter. The chemical engineering industries are no exception to this rule. Fortunately, however, our industrial group is more concerned with the general economic and social consequences of the session than with any one or even half dozen of the measures that might have specific influence upon our industrial activities.

The old political game apparently is to be played without any extensive revision of the rules. Senator Norris wants to have that perennial football, Muscle Shoals, become the major center of interest. Already there are partisan and block huddles on the political gridiron, and it may be that the Nebraskan advocate of public ownership of power properties and governmental operation of manufacturing works will be able to concentrate interest on his particular football. Any reader of the daily press, however, is well aware that there are a dozen, if not a score, of other powerful individuals or groups that insist on playing the game with their pet project instead. Who will write the rules, no one can yet say.

The real concern of conservative leaders in both political parties is to avoid a special session of Congress. If they were allowed to write the rules of the game for the winter they would rule all these pet projects out of bounds and concentrate the effort of Congress on passing the routine and vital appropriation bills and caring for the most urgent of unemployment-relief, drought-relief, and related measures. Only time can determine whether they will be able to prevail in the fixing of such policy. If they can do so, then it would appear that they should have the earnest and sincere co-operation of all industrial groups, even though it may be necessary at times to sacrifice certain measures that to these industries seem of real importance.

Actually, it probably will be much better for the country to be relieved of the uncertainty which always follows radical debate in Congress than to have any one or a dozen legislative enactments accomplished. In so far as the chemical engineering industries have an influence in these matters, *Chem. & Met.* believes that they should exert it to secure prompt legislative consideration of appropriation bills and vital relief measures with a view to adjournment of Congress on March 4, not to meet again until December, 1931.

When Chemical Meets Chemical

WITHIN the past few days, two successive announcements from government sources have symbolized neatly, no less than authoritatively, just what is entailed in the present-day status of chemical industry and competition. Perhaps the only group not directly interested in the omen is that engaged in fundamental research; all others—engineers, economists, and executives—will thankfully accept the double-edged moral, especially when dispensed so clearly and gratuitously. And this fundamental lesson is simply that each chemical product is increasingly both a threat and a victim to its fellow products, to an extent governed in great part by the engineering and economic knowledge supporting it.

As part of an investigation on methanol, the Public Health Service and the U. S. Bureau of Mines report in a preliminary conclusion that "there is no danger of poisoning from the reasonable use of methanol as an anti-freeze for automobile radiators." Their discussion and recommendations form a sound and doubtless thoroughly safe basis for further steps in new applications of synthetic methanol; furthermore, the investigation is an excellent example of effective co-operation between industry and government, in the interests of the consuming public. Meanwhile, other anti-freeze compounds face a serious contender.

Collaterally, Dr. James M. Doran, director of the Bureau of Industrial Alcohol, has announced the result of a three-year research by which a chemical mixture from cracked California petroleum will displace methyl alcohol as a complete denaturant for industrial alcohol. The new denaturant is vile in taste but not poisonous, and should henceforth prevent such fatal poisonings as have occurred in the past. It would appear that the destiny of methyl alcohol is governed in this case by the property of toxicity alone and that a competing product,

developed for this very reason by research, has capitalized on this property.

Well, other conclusions swarm, but the fact of inter-commodity competition does stand out pre-eminently as a vital element in the life, not merely of methanol, but of all chemical products. Study and knowledge, both technical and economic, are necessary to clarify the increasing contention. Therefore, in its annual January survey, *Chem. & Met.* will make inter-commodity competition the keynote of a searching analysis, and thus afford an insight into the mutually conditioning trends of today's chemical industry.

Fires That Lose Customers

LOSS by fire in an industrial plant is not limited to that part of the investment in building and equipment that cannot be entirely covered by insurance. This is often relatively small and unimportant compared to the much larger and more impressive loss in business. Inability to fill a customer's orders for a period of a few months or a year is serious. He turns to a competitor for his supplies. The temporary loss of his business may mean the permanent loss of a customer. If the forced inactivity is of long duration, disorganization of personnel follows, with the loss of valuable employees. These are some of the unfortunate consequences of industrial conflagrations that we must guard against.

Most fires can be prevented by applying a few well-known principles. Fireproof building construction, automatic sprinkler systems, and company-owned fire apparatus greatly reduce the interruptions to business caused by ordinary fires. However, in chemical industry special measures are often necessary to minimize the danger of fires from dust explosions, spontaneous combustion, and the ignition of flammable vapors by unguarded gas flames, static electricity and short-circuits.

Fortunately, through the work of the National Fire Protection Association and similar agencies, a great deal of helpful information is available to chemical industry. Management has a responsibility to make full use of it.

Patent Confusion Threatened By Proposed Legislation

ONE of the most dangerous proposals regarding patents that have ever received serious attention in Congress is offered in the form of the so-called "Dill Bill." The effect of this bill would be virtually a destruction of all patent rights held by a corporation if it appeared that any of the activities of that corporation were interpreted as directly or indirectly in violation of the laws regarding combinations, trusts, monopolies, or illegal patent licensing agreements. Others interested in the use of the patented process or product could infringe with impunity and find complete defense for their infringement if they could merely prove that the patent owner was demonstrably subject to any of these charges.

In these days of complicated industry, no corporation, even with the wisest and the best intention of management, can entirely escape the chance that it may be in some measure judged in violation of rules or laws regarding restraint of trade. Even the best of government officials and the ablest of corporation attorneys dispute the legality of many practices. Such corporations, with proper motives and with no real public damage, may find themselves adjudged guilty on occasion. It is absurd that such corporations should thereby lose their entire patent protection for all classes of patents which they own, regardless of the connection with the alleged illegal practice on some other detail. Yet this is exactly the effect contemplated by the Dill bill, if enacted.

The bill in question, S. 4442, has been considered by the Senate Committee on Patents and has been favorably reported to the Senate for the committee by Mr. Dill, its author. We can hardly believe that even the Senate will pass the bill, much less the House of Representatives. And we feel that President Hoover would veto it if passed, and would be supported in such veto. Yet, it is such a dangerous proposal, so insidious and far reaching in its effects if seriously considered, that everyone should use his full influence to insure its defeat.

Can't We Eliminate The Common Hazards?

CHEMICAL MANUFACTURE has had to live down an unjustly acquired reputation as an especially hazardous occupation. Gradually we are building up a background of safety experience to prove that accident prevention in the chemical industry is not different fundamentally from that in other industries. Accidents have definite causes that can be prevented when we recognize and eliminate the hazards—chemical, mechanical, or human. Protective devices and equipment that have demonstrated their value in other industries are now being used more and more effectively. Most important, although sometimes most difficult of all, is the problem of educating the employee in the principles and practices of safety. Therein lies the only solution for the thoughtless, careless causes of much of our trouble.

This year the Chemical Section of the National Safety Council, under the chairmanship of John S. Shaw, of the Hercules Powder Company, plans to give much of its attention to the common garden variety of accidents that have come to make up such a large proportion of our industrial casualties. A broken arm from a ladder fall or a sprained ankle from a skid on a slippery floor has terminated many a brilliant no-lost-time accident record. These are pertinent problems of the small plant where safety work has not yet been made a co-ordinated part of production activities. The Chemical Section is to be congratulated on its decision to serve in this less spectacular but eminently practical rôle.

Are We Nearing

POTASH INDEPENDENCE?

By THEODORE R. OLIVE
Assistant Editor, Chem. & Met.

U. S. Bureau of Mines Laboratory at Highland Park, New Brunswick, N. J.

OF THE THREE indispensable plant food materials, nitrogen, phosphorus, and potash, only in the case of the last is the United States seriously dependent, at present, on foreign producers. Nitrogen supplies are obviously inexhaustible, and there are no technological reasons why all of our nitrogen demand should not be supplied by domestic production. Phosphate rock mined only within our borders could, if necessary, supply our phosphorus needs indefinitely. Potash alone has been a doubtful quantity. Even now, it is not a foregone conclusion that our resources are capable of competing on an economic basis for the entire United States market. But developments of the past few years point more certainly to this desirable possibility. At least four potash sources: natural brines, sylvinite, wyomingite, and polyhalite, the last three as yet unexploited, may become serious competitors in a market now dominated by foreign production.

The history of potash is one of three periods. Prior to 1861, when potash salts were first produced from the German Stassfurt deposits, there had been a flourishing pearl ash industry of considerable importance in the United States, based on the leaching of wood ashes to produce potassium carbonate. About 1850 this industry began a decline and had fallen to one-quarter of its 1850 size when the first German potash was imported in 1871. From this point, pearl ash production continued to decrease rapidly until it had practically disappeared at the turn of the century. Meanwhile, imports increased as the use of potash for fertilizers became general, until by 1910 imports amounted to about 220,000 tons of equivalent K_2O, approximately two-thirds of their present value.

The year 1910 saw the beginning of a second period. Prior to this date the German Potash Syndicate had had little difficulty in maintaining monopolistic prices. As the sole important producer for export, the syndicate controlled the world potash situation. However, independent German producers had gained in power to such an extent in 1910, that the syndicate, that year, forced the passage of the German potash law, which gave the German government complete monopolistic control. This proved to be the first incentive for the development of an American potash industry. In 1911, Congress made available a small appropriation for the investigation of potash resources by the Geological Survey and the Bureau of Soils. This joint arrangement was continued until 1926.

Curtailment of German shipments in 1914 was actually the determining factor in the second period. Before that date, there had been practically no domestic production, in spite of the government investigation. In that year, a small amount of potash was made from kelp in California; and at the same time, research was instituted by private interests in the utilization of the Searles Lake (Calif.) brines. When in 1915, however, the blockade cut off German potash entirely, large-scale efforts were made for the first time to remedy the situation. Prices jumped 1,300 per cent, and five domestic plants went into operation, using as raw materials, cement dust, alunite, kelp, and Nebraska brines.

During the final war years, rapid development con-

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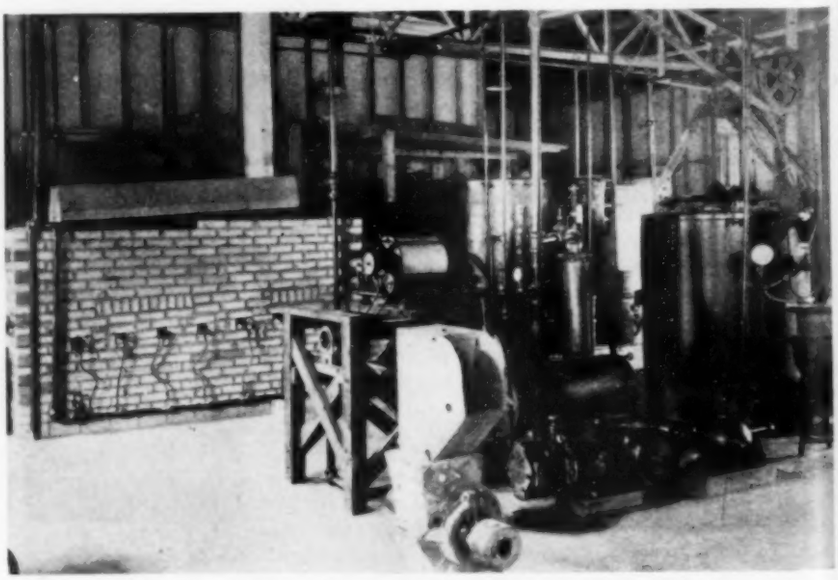
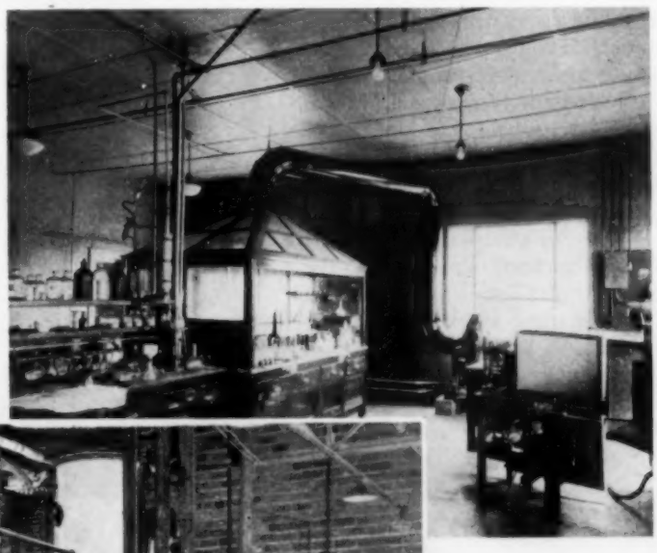


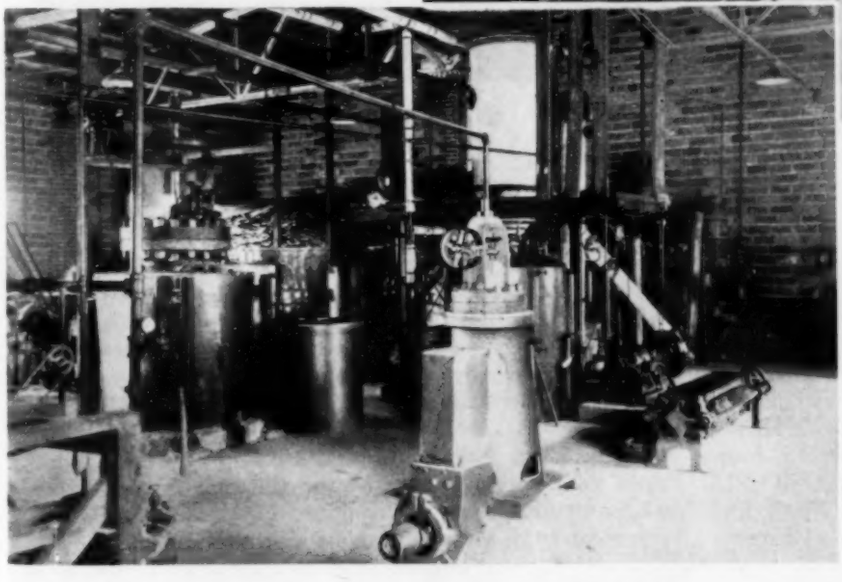
Part of the Semi-Works Laboratory, Showing Rotary Kiln, Hammer Mill, Dorr Agitator, Storage Tank, and Vacuum Filter

tinued. Additional potash sources were utilized, including blast-furnace dust, silicate rocks, distillery and sugar refinery wastes, and wood ashes. By 1918, production had increased to about 20 per cent of our normal pre-war demand, and prices had dropped to about 750 per cent of the 1913 level. In that year, there were 128 producing plants, including 51 factories that were operating on wood ashes.

Signing of the Armistice ushered in the third period in United States potash history. Prices dropped and almost immediately many producers were forced to shut down. By 1920 only half of the peak number of plants was in operation. It was in that year that foreign potash returned in considerable amount, equalling about 80 per cent of the pre-war import. Germany had ceded the Alsatian deposits to France, and both countries were very actively engaged, the one in building and the other in rebuilding, a war-demoralized potash business. The 1921 agricultural depression set in, and domestic production fell to the lowest point (except 1922) reached between 1915 and the present. Closing down of domestic producing plants continued until only 20 were left. Of these, only two concerns of any considerable importance as potash producers were able to survive the year. These were the American Potash & Chemical Corporation, operating on natural brines at Searles Lake, and the U. S. Industrial Chemical Company, making potash as a by-product of distillery wastes, at Baltimore. Business recovery in 1923 brought about a slight increase in domestic output, all the increase, however, at Searles Lake. In 1924 an agreement was reached between the French and German producers, culminating some four years of negotiations and considerably strengthening the position of these factors in the American market. This arrangement eventually allocated 30 per cent of the foreign market to France and 70 per cent to Germany, and raised prices slightly.



Analytical Laboratory at Highland Park; Note Duriron Exhaust Fan and Miniature Rotary Kiln at Right



Another End of the Semi-Works Laboratory, Showing Two 1,000-Lb. Autoclaves, Zaremba Evaporator, Filter Press and Auxiliary Equipment

Meanwhile, the two domestic producers continued to account for practically all of the United States output. Production increased continuously, except for a recession in 1926, until in 1928 American Potash & Chemical Corporation turned out nearly 60,000 tons of potash expressed as K_2O, and U. S. Industrial Chemical Company, about 4,500 tons, representing approximately one-sixth of the total consumption. It is believed that these production figures have not been materially increased since 1928.

Lessons of the war years were not forgotten during the latter part of the period. Very obviously the United States could not become independent of foreign producers without extensive preliminary investigation. It was recalled that oil-well drillings had shown potash minerals in Texas as early as 1912. Private capital was exceedingly chary of the expenditures that would be needed to demonstrate the extent of these deposits. It devolved upon the government to do so, and, having obtained an appropriation, the Bureau of Mines commenced drilling in western Texas and southeastern New Mexico in 1927. As a result of these investigations, it appeared that several minerals, including sylvinite, carnallite, kainite, langbeinite, and polyhalite, were present; only the latter, however, in commercial quantities. Polyhalite ($2CaSO_4 . MgSO_4 . K_2SO_4 . 2H_2O$) was found over a considerable area at depths averaging 1,200 ft. The other minerals did not appear to be very widely disseminated.

Although only a small quantity of polyhalite could be obtained from the drill cores, work on methods for its utilization was immediately started at the Non-Metallic Minerals Experiment Station of the U. S. Bureau of Mines at New Brunswick, N. J. Additional polyhalite was obtained from Poland, where small quantities of the mineral are found, associated with the sylvinite which forms the principal part of the deposit. A further small quantity was supplied by an oil concern that had been drilling in southeastern New Mexico in search of sylvinite, which it had first discovered in oil well cuttings in 1925.

Work on polyhalite progressed satisfactorily, and two processes, one yielding substantially pure K_2SO_4, and a double salt, $K_2SO_4 . MgSO_4$; the other producing only K_2SO_4; were developed through the laboratory stage. Sufficient raw material, how-

ever, was not available for a semi-plant scale demonstration of the entire process, although evaporation characteristics have been investigated. Computations based on this work indicate that potassium sulphate (90 per cent K_2SO_4) can be produced at the plant for less than $16 per ton of K_2SO_4; and that the double salt (48 per cent K_2SO_4) can be similarly produced for slightly under $8. The detailed calculations are given by J. S. Wroth in Bureau of Mines Bulletin 316. As developed in this publication, the 90 per cent sulphate salt could be set down in Atlantic ports at a price of $29.16 per ton of salt. This compares with a price in Atlantic ports of $35.17 for the German 90 per cent sulphate. The advantage for the domestic products would be considerably greater at other points, except on the Pacific Coast, where, at present freight rates, the advantage would lie considerably with the imported material.

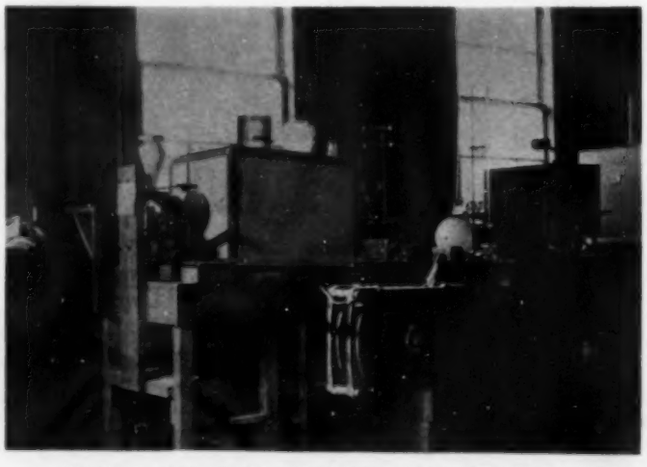
IN THE FIRST of these processes, polyhalite is crushed to 28-30 mesh, and calcined in a rotary or multiple-hearth kiln at 450-500 deg. C. for 30-60 minutes. It is then extracted in mechanical agitators with fresh water at 100 deg. C. Only $CaSO_4$ fails to go into solution, and this is separated by filtration. The filtrate is evaporated and cooled, separating crystals of K_2SO_4. The mother liquor is further evaporated and cooled, dropping schonite, K_2SO_4 $MgSO_4$ $6H_2O$, which on drying becomes the finished sulphate of potassium-magnesia. The yield is indicated to be 86 per cent on the K_2O content.

If, instead of the two final products, only K_2SO_4 is desired, a slight modification is all that is required. Instead of the first evaporation, the filtered polyhalite extract is mixed with schonite from the last step. On cooling and crystallizing, the solutions drop K_2SO_4, which is removed by settling and filtration. Then evaporation of the filtrate, followed by cooling and crystallization, produces the schonite, which is added to the extract as mentioned above. The final mother liquor contains the $MgSO_4$, which is discarded.

While these processes were being developed, private interests were not idle. The oil company referred to above became convinced of the presence of very considerable quantities of sylvinite in Texas and southeastern New Mexico. A company was formed to explore this deposit, and it is now of the opinion that the sylvinite resources alone are sufficient to supply the entire United States demand for many years. Sylvinite is a eutectic mixture of KCl and NaCl, which occurs in horizontal beds at an average depth of 700 ft. In recovering its KCl content, it is necessary only to extract the ore with hot NaCl brine, from which the KCl is separated by crystallization. It is evident that the production of potash salts by the sylvinite process can be accomplished much more cheaply than by any process for treating polyhalite which has yet been at all thoroughly investigated. Provided the sylvinite deposits are actually as extensive as they are now believed to be, this process appears to promise opportunity for large development.

An equally interesting proposition has been investigated in Wyoming. At Superior, within a few rods of the railroad, there is an extensive formation of wyomingite, an aluminum silicate-silica rock containing about 50 per cent leucite ($K_2O \cdot Al_2O_3 \cdot 4SiO_2$). This mineral is composed of about 11.5 per cent K_2O, 51.7 per cent SiO_2, 13 per cent Al_2O_3, and the balance Fe, Ca, Mg, Na_2O, and P_2O_5. The engineering firm of Pike & West, of Emeryville, Calif., set about the development of a process to utilize this material, the results of which are embodied in U. S. Patent 1,770,995. This process makes ingenious use of several other raw materials found within reasonable distances of Superior to yield a concentrated fertilizer material containing both potassium and phosphorus, KH_2PO_4. At Green River, 41 miles from Superior, there are soda brine wells, the liquor of which contains about 11 per cent solids. Of this, 8.3 per cent of the total is Na_2CO_3, a necessity for the Pike & West process. The distances from Green River to the other raw material supplies are as follows: phosphate rock at Georgetown, Idaho, 137 miles; sulphuric acid, Garfield, Utah, 230 miles; natural gas, South Baxter Basin, 21 miles; and sub-bituminous coal and slack, 15 miles.

In this process, the soda brine is concentrated and used to leach ground wyomingite, yielding a mixture of potassium and sodium carbonates. The sodium carbonate is salted out in an evaporator, and the K_2CO_3 removed by crystallization. The product is treated with sulphuric acid and phosphate rock, and the resulting KH_2PO_4 isolated by crystallization. Sodium carbonate is obtained as a byproduct. It is understood that a California group is giving serious consideration to further development of the process. Apparently the only possible difficulty is early exhaustion of the soda brine. This material has been pumped experimentally, with no evidence of diminution in volume. So far as the wyomingite is concerned, its date of exhaustion would be a matter of small concern to the present generation. According to an estimate by J. R. Thoenen, of the Bureau of Mines, material in sight at Superior, and well located with respect to the railroad, amounts to 940,000,000 tons of wyomingite, sufficient to supply, at present needs, the entire United States potash demand for at least 235 years.



Miniature Rotary Kiln Used for Calcining Polyhalite

Whether one or several of the processes already mentioned will be the ultimate solution to our potash independence, or whether it will be found among those on which work is now being planned by the Bureau of Mines, cannot be said. It can only be stated with conviction that domestic production of all or any part of our needs will undoubtedly be possible in the not too distant future.

Several new projects for the utilization of polyhalite are in the formative stage by the Bureau. The station at New Brunswick is well equipped for the work, as will be evident from the photographs reproduced here. Sev-

eral laboratories in the Ceramics Building at Rutgers University are being used by the Bureau. There is in addition the Highland Park Building, which houses offices, a complete analytical laboratory, and a chemical engineering laboratory well supplied with small-scale process equipment. This includes a 6-in. x 11-ft. rotary kiln equipped with a six-point pyrometer recorder; a small Dorr agitator provided with steam coils; a miniature vacuum filter; a small plate and frame filter press; three 1,000-lb. autoclaves of 100, 15, and 1 gal. capacity; and an experimental Zaremba evaporator with external heating for either forced or natural circulation. There is also reduction equipment, including ball mills, a crushing roll, and a swing hammer mill. Auxiliary equipment

Staff of the Non-Metallic Minerals Experiment Station of the U. S. Bureau of Mines

includes a compressor, pumps, a vacuum pump, platform scales, storage tank, 15-hp. boiler, and a machine shop.

Interesting possibilities are offered by the polyhalite processes now under consideration. In one process which has had the benefit of partial laboratory investigation, calcined polyhalite is treated at 25 deg. C. with K_2SO_4 liquors produced by a hot water extraction of the calcined mineral. This gives an 87 per cent yield of syngenite (K_2SO_4 $CaSO_4$ H_2O) which separates on crystallization. Dry syngenite may be produced, according to preliminary estimates, for $5 per ton at the plant in Texas. The cost per ton delivered in the South Atlantic states would be about $13. This product would contain from 46.5 to 50 per cent of K_2SO_4. It is rapidly decomposed by water at ordinary temperatures, yielding a solution containing 3.2 to 3.5 grams of potassium sulphate per 100 grams of water. This definite but limited solubility should make this material more desirable as a fertilizer than more concentrated forms of potash salts, which have higher solubilities and hence involve the danger of plant injury due to the presence of high local concentrations of potash.

Several processes have been suggested for the production of KCl from polyhalite, but only one has thus far been tested. This involves the extraction of uncalcined polyhalite with boiling, saturated NaCl solution. Subsequently the brine thus obtained is evaporated, giving an over-all yield of about 80 per cent and a production cost of about $20 per ton of pure KCl, at the plant in Texas. It is apparent that this process will not be an economically desirable one if deposits of sylvinite, capable of industrial exploitation, exist in Texas and New Mexico.

Still another process has been proposed to make potassium sulphate and ammonium sulphate, either as a mixture or separately. Calcined polyhalite is extracted with hot water and the cooled extract treated with 3-4 mols of $(NH_4)_2CO_3$ per mol of $MgSO_4$. The solution drops $MgCO_3$ $(NH_4)_2CO_3$ $4H_2O$, from which byproduct magnesium carbonate may be recovered. The excess ammonium carbonate is recirculated. The mother liquor from the magnesium ammonium carbonate crystallization, on evaporation, yields 10.5 parts of K_2SO_4 and 8.2 parts of $(NH_4)_2SO_4$ for every 100 parts of water.

There are still other processes, the investigation of which is in prospect. Several of these anticipate the use of polyhalite, others of leucite minerals. It has been suggested that the reaction of leucite with carbon and nitrogen at high temperatures in a blast furnace may be used in making KCN, which could be converted to potassium carbonate. This reaction might perhaps be forced by increasing the partial pressure of nitrogen in the furnace. It may also be possible to react leucite with ammonia and carbon dioxide to make ammonium and potassium carbonates.

The use of the blast furnace and acid methods of extracting potash are being investigated by the Fixed Nitrogen Laboratory of the Bureau of Chemistry and Soils, U. S. Department of Agriculture.

All of this indicates clearly that the potash situation is far from settled. The New Jersey greensands probably are eliminated as a possibility because of the enormous output of byproducts that would have to be produced concurrently in making greensand processes pay. Except as minor sources of potash, the byproduct processes, such as cement dust and distillery wastes, will remain of relatively small importance. The alunite deposits and certain natural brines, such as those of Nebraska, Utah, Nevada, and Texas, await economically suitable processes before they can be considered in normal times. But between the Searles Lake, wyomingite, sylvinite, and polyhalite possibilities, it is not unlikely that another decade will find the United States in a position of imminent, if not actual, potash independence.

In the preparation of this article, the writer acknowledges free use of several publications of the U. S. Bureau of Mines. Particularly, he wishes to express his appreciation for the co-operation of H. H. Storch, supervising engineer of the Non-Metallic Minerals Experiment Station, for aid in the preparation and for criticism of the manuscript; and to A. C. Fieldner, chief engineer of the Experiment Stations Division of the Bureau, for his suggestions and criticism.

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Sulphurless Rubber Avoids Tarnish

INVESTIGATION by the U. S. Bureau of Standards has shown that the use of 1, 3, 5 trinitrobenzene instead of sulphur as a vulcanizing agent for rubber produces a product which has no apparent action on such metals as copper, silver, and mercury. For example, when trinitrobenzene rubber is vulcanized in contact with copper, the metal remains bright and the aging qualities of the rubber are practically unaffected. Such rubber may find an important application in the manufacture of electrical insulation, since it may be applied directly to the copper without first tinning the latter. The resistivity is somewhat less than that of sulphur-vulcanized rubber, but adequate for practical insulation purposes.

Southern Industries Report Advances Through Chemical Engineering

NEW ORLEANS, focal center for many chemical interests and source of basic chemical raw materials, was again the scene of the annual meeting of the American Institute of Chemical Engineers. Petroleum hydrogenation, natural gas, salt, pulp and paper, insulating lumber, sugar, and naval stores are among some of the industries discussed in fifteen technical papers reported here.

EDITORIAL STAFF
REPORT

HYDROGENATION was the lodestone that attracted many chemical engineers to New Orleans for the technical sessions of the American Institute of Chemical Engineers, Dec. 8, 9, and 10. The selection of this topic was particularly pertinent because New Orleans had a prominent part in the early history of cottonseed oil hydrogenation and because Baton Rouge, near by, was the scene of the first American work on the hydrogenation of petroleum. Furthermore, the great natural gas fields at Monroe and Sterlington represent one of the largest potential sources of hydrogen for chemical industry.

Marion W. Boyer, who, as director of research of the Standard Oil Company of Louisiana, had a prominent part in the engineering development of the petroleum hydrogenation process, traced the progress of that work through the 100-bbl. per day plant at Baton Rouge and then sketched the commercial applications that are being demonstrated at the 5,000-bbl. plant at Bayway, N. J. Carlton Ellis, consulting chemist and president of the Ellis-Foster Company, of Montclair, N. J., had been assigned to discuss the use of hydrogen in chemical industry, but, having just returned from a comprehensive tour of European chemical plants, he was persuaded to report his observations of some of the newer foreign processes of high-pressure synthesis. He described hydrogen manufacture and purification as carried out by the I. G. at Leunawerke in connection with coal and tar hydrogenation. An interesting experimental application observed in England was the use of hydrogen under pressure to give coking properties to non-coking coal. Mr. Ellis displayed many samples of products made by the hydrogenation of coal in England and Germany. On the other hand, J. F. T. Berliner and George W. Burke of the DuPont Ammonia Corporation presented a paper on the dissociation of anhydrous ammonia into its elements, which is published in full elsewhere in this issue.

The long-distance transportation of natural gas, discussed by Edward G. Hill and George I. Rhodes, vice-presidents of Ford, Bacon & Davis, of New York, is of dual interest to the chemical engineer. In the first place, it makes available to him over a widespread area an abundant supply of a cheaper and richer fuel for process use. Secondly, as a raw material in certain processes of chemical synthesis, it is becoming increasingly important. The authors deprecated as grossly inefficient, however, the use of natural gas in carbon black manufacture. A thousand cubic feet of natural gas contains about 35 lb. of carbon, yet only about 1 to 1½ lb. is recovered by the usual processes. The pipe lines, such as the 24-in. line, approximately 1,000 miles long, extending from Amarillo, Texas, to Chicago (now under construction), will have a capacity of excess of 200,000,000 cu.ft. per day. The authors presented as typical of cost relationships in the construction of such a line operating at 350 lb. pressure, the following equation:

$C = 2{,}000\ L + 500\ LD + 50\ LD^2 + 100{,}000\ N + 125\ HP$ where C is cost in dollars, L is length in miles, D is the outside diameter of the pipe in inches, N the number of compression stations, and HP the total power of the stations.

A paper by Smith D. Turner and J. E. Pollack, of the Humble Oil Refining Company, dealt with the extrapolation of vapor pressures of a petroleum fraction from the known value at some temperature to a higher working temperature. This has ordinarily been done by paralleling the lines for pure hydrocarbons on a vapor pressure chart of the paraffin series. Although the authors' investigations have not yet covered more than a part of the range of petroleum fractions, it has been shown that the approximation mentioned is highly inaccurate. Data already available for gasoline were correlated yielding a chart which made possible extrapolations of good accuracy. Heavy charging stocks were investigated in a bomb of special design. The data so obtained showed that extrapolation from curves for pure compounds gave rise to very large errors. Further work is needed in this field.

A paper on sodium metasilicate, a new industrial alkali, attracted a great deal of favorable interest when read by J. G. Vail, director of research of the Philadelphia Quartz Company. It appears elsewhere in this issue. Two other discussions had to do with the production of insulating board from Southern sources; namely, waste wood from sawmills and bagasse from sugar mills.

In the account given by Robert M. Boehm, director of research of the Masonite Corporation of Laurel, Miss., of the industry built up on exploded wood, the most interesting feature undoubtedly was the ingenious process around which the operations center (see *Chem. & Met.* June, 1927, and November, 1929). Wood, reduced to chips by chippers and breakers, is subjected to an ultimate steam pressure of 1,000 lb. per square inch and then discharged into the open. The steam that has found its way into the pores of the wood thus suddenly expands

and blows the chips into woolly "gun" fiber. After this fiber is refined in mills, it is carried by water on a traveling wire screen where a mat is formed which is ultimately pressed into various kinds of structural and insulating boards. This company produces three grades: A porous board essentially for insulation; a firmer intermediate board; and a hard, glossy board of high density and tensile strength.

The transformation of sugar-mill waste, or bagasse, into a useful structural board was the subject treated by Elbert C. Lathrop, director of research of the Celotex Company, Chicago, Ill. The bagasse is purchased from the sugar mills in only two or three months during the year, a circumstance that entails the storing of large quantities of this material, which, unfortunately, is spontaneously combustible; however, this phase of the problem has been satisfactorily solved. After the bales are broken, the material proceeds through digesting, cooking, and shredding operations, distinguishing itself from other pulp in that it does not float in water, so that large stock chests and powerful agitators are necessary. Sizing agents are introduced before the pulp reaches the board machine on which the water is drained and expressed. These machines are practically automatic. Because an 800-ft. dryer was required and was not commercially available, the company built its own and now has two of this length in addition to one 1,000 ft. long. The final operations are seasoning, sawing, and inspection.

The recent marked decline in the price of anhydrous aluminum chloride has stimulated widespread interest in further uses for it, either in new processes or in the expansion of existing applications. It is estimated that almost a million pounds of this halide is used in the manufacture of anthraquinone and its derivatives by means of the Friedel and Crafts reaction. This subject was discussed comprehensively by P. H. Groggins, senior chemist, Color and Farm Waste Laboratory, Department of Agriculture, Washington, D. C. Owing to the exceptional fastness of the vat colors and the fact that they are being made available at progressively lower prices, their consumption has increased at a phenomenal rate.

The Gulf Refining Company not only produces but consumes about 95 per cent of the aluminum chloride made in the United States. Its use in the cracking of heavy petroleum fractions insures a distillate which is free of unsaturates. The following data show to what proportion the aluminum chloride industry has grown:

Production of Aluminum Chloride in the United States (1924-1929)

Year	Total Production (Lb.)	Anhydrous Al_2Cl_6	Anhydrous Al_2Cl_6 by Gulf Refining Company	Crystals $Al_2Cl_6 \cdot 12H_2O$	Solution 30 Per Cent Al_2Cl_6
1924	11,020,000	.....	10,718,699	.....	.....
1925	25,665,000	.....	21,386,530	.....	.....
1926	33,500,000	.....	27,264,297	.....	.....
1927	.....	28,200,000	26,550,186	540,000	5,520,000
1928	.....	27,990,000	27,016,750	744,000	4,806,000
1929	.....	27,574,000	26,840,146	730,000	4,798,000

Aluminum chloride also is being produced at present by the displacement process from aluminum bromide and by an electrochemical method. A colorless product of high purity classified as to sizes is obtained by these methods. Experiments show that it is inadvisable to use powdered reactants in the Friedel and Crafts reaction, because of their tendency to absorb atmospheric moisture and thus react too rapidly.

Present chemical engineering activities at the Color Laboratories with equipment of a novel design may lead to the introduction of reactors which make possible the carrying out of the Friedel and Crafts reaction in a continuous process. The success of these investigations would undoubtedly have a pronounced effect on activities in this field.

The youngest branch of naval stores industry carries the cumbersome name of the steam-distillation, solvent-extraction process. Despite this handicap, however, it has grown more rapidly in recent years than the gum rosin and turpentine industries. This progress has been due largely to the introduction into this industry of modern chemical engineering methods and equipment. V. R. Croswell, manager of naval stores operations for the Hercules Powder Company at Hattiesburg, Miss., and his associate, R. Rockwell, described some of these interesting engineering features. Beginning with the ingenious new methods developed for pulling the stumps and harvesting the wood from the cut-over pine lands of the South, they described the preparation of the chips, the eduction of the turpentine, rosin, and pine oil, and their fractionation and purification. The handling of the solvent naphtha and the corrosion problem of the superheated steam called for real chemical engineering research. At present the spent chips are used for steam generation, but they may eventually find more profitable outlet because of their cellulose content.

Because of Louisiana's relation to the alkali industry of the future, much interest was shown in the paper by Prof. R. A. Steinmayer, of Tulane University, who discussed the possible origin and development of American salt domes. Despite debated origin, these salt domes have buried in them much of the future wealth of the Southern states. Although geographically, salt-bearing deposits have been found to encircle the earth, the peculiar structural forms termed "salt domes" are known to occur only on the North American continent. Furthermore, a large majority are found in the South and Southwest. Salt domes may have associated with them many essential and accessory minerals, such as sulphur, and every salt dome may be looked upon as a potential oil field.

Because of changeable climate, particularly in the South, artificial drying of hay brings agriculture into the province of the chemical engineer, as was pointed out by Prof. William Whipple, of Louisiana State University. The indirect method was first used, but was largely superseded by the direct method when it was discovered that furnace gases made a suitable and harmless drying medium.

Louisiana State University has built a single-drum-type rotary kiln dryer with the furnace gases at 1,500 deg. F. to 1,600 deg. F. coming in contact with the cold wet material cut into short lengths to separate leaves from stems. The gases rapidly give up the quantity of heat required for heating and evaporation and are drawn out almost completely saturated at a temperature of about 160 deg. F. An induced draft fan operating on low-temperature gases produces in the dryer a current of air which carries out of the hot zone all particles of low density and discharges a uniform product with any desired degree of dryness. This system results in a saving of fuel and power costs due to the small quantity of excess air required and the high thermal efficiency obtained.

Editor's Note: **A news account, including the list of new officers elected at the New Orleans convention, appears on p. 775 of this issue. In addition to the foregoing abstract, six of the papers mentioned are published in this issue of *Chem. & Met.***

Producing Kraft Paper From Southern Pines

By R. H. STEVENS

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Bogalusa, La.

THE astonishingly rapid increase in paper manufacture in the South in recent years is but a logical development, in view of the economic advantages of this region. For in the South there is the fortunate combination of cheap raw materials, cheap fuels, plenitude of good water, abundant labor supply, and close proximity to rapidly expanding markets. In no part of the country do the forests reproduce themselves so rapidly as in the Gulf coast region, with its favorable climate and extensive areas of non-arable tree-covered lands. Here there is every type of fuel in abundance: wood waste from sawmills, most of which is burned for disposal without benefit; natural gas from the most extensive fields yet discovered; petroleum from seemingly inexhaustible pools and plenty of good, easily mined, steam coal. The South also is rich in salt, sulphur, and lime, which furnish the chemicals required for the pulping process.

The first attempt to make paper from Southern pine was in an experimental plant at Pensacola, Fla., about 1908. The equipment was later moved to Orange, Texas, where kraft paper was manufactured until early in the present year. In 1913, the Southern Paper Company began operation at Moss Point, Miss., and the Bogalusa Paper Company five years later. Today there are twelve large mills with a capacity of 540,000 tons a year, or approximately 52 per cent of the entire national consumption of kraft papers. And there are rumors that three mills are to be built in the near future.

These mills employ the sulphate process, cooking with a solution containing sodium hydroxide and sodium sulphhydrate as active reagents. Though this process has been in use since 1882, our fundamental knowledge of the chemical reactions is woefully inadequate. Replacing with the sulphhydrate, as little as 2 per cent of the caustic soda changes the character of the products. The pulp becomes stronger and methyl mercaptan appears among the volatile products. When 15 per cent of the active alkali is in the form of sulphohydrate, the fiber acquires the characteristics of a true sulphate pulp. Further increase in the quantity of sulphohydrate has little effect until it exceeds one-half the active alkali, when effectiveness of the reagent begins to diminish.

The quantity of active alkali varies from 15 to 18 per cent of the dry weight of wood used in making kraft pulp to as high as 25 per cent for bleachable pulps, the alkali being expressed as Na_2O in either case. The concentration of alkali is of importance also, but available data are contradictory. Use of black liquor in diluting the white appears to have a catalytic effect. The sulphate treatment is more rapid than the soda and the pulp is more easily bleached when cooked to the same yield. Present tendency is toward higher treatment temperatures, with correspondingly shorter time. Apparently the quality of the product does not suffer by employment of higher temperature, provided the processing is carefully controlled.

The present tendency is toward stationary digesters of large size with the liquor circulated through an outside heater. Direct steam is used for heating after the digester has been brought up to a pressure of 90 lb. per square inch, both for steam economy and to avoid corrosion of the heater tubes. Automatic control of the cooking cycle would be a logical development, but has not yet been adopted in the South. A prerequisite would be adequate means for measuring the amount of wood charged into the digester, but apparently the pulp industry is the last of the chemical engineering industries of major importance to regulate its chief raw material by guess.

Several byproducts are obtainable from the treatment of the wood—viz., turpentine, methanol, and ammonium sulphate. Though all are reclaimed in some of the Swedish mills, only the turpentine is recovered here.

Paper Machine in the Mill of the Bogalusa Paper Company, Bogalusa, La.

Washing in diffusers has been common practice, though the Texas mill employed the open wash pans. A recent development is washing on the rotary filter. The foam of black liquors made from resinous Southern pines creates a problem in filter washing that requires much ingenuity to overcome. Other means suggested are the screw press and the centrifugal extractor. Control of washing is still maintained by manual hydrometry, though con-

Presented on Dec. 10, 1930, at the New Orleans meeting of the American Institute of Chemical Engineers, under the title, "The Development of Paper Manufacture From Southern Pines."

ductivity measurements and the photo-electric cell are being tried experimentally.

A resinous byproduct, half resin and half fat, can be obtained from the black liquors by acidifying the soap which causes the foam. At the present price of wood rosin, however, there appears to be little possibility of profitable recovery.

Numerous types of vacuum evaporators are employed for concentrating the black liquors, but the Zaremba and Swenson appear to be the most popular. A recent innovation is the pressure concentrator used particularly in connection with the spray-in type furnace. The latter is beginning to replace the older smelter, hand-fired with black ash. There is still some question which type gives the best reduction and recovery, though there can be no doubt of the economy in labor and steam obtained with the spray-in furnace. In none of the Southern pine mills have waste heat boilers been installed in connection with rotary incinerators, as in some of the Lake States mills.

The sodium sulph-hydrate which makes possible the utilization of the Southern pines for paper making is derived from sodium sulphate applied in the form of salt cake by reduction with carbon. The latter is supplied by the dissolved portion of the wood. The recovered alkali is practically all in the carbonate form, though some of the spray-in furnaces are said to reclaim part of it as caustic. Almost none of the sulph-hydrate is reclaimed as such. Therefore, the quantity of salt cake used determines the sulphur content of the liquor. Great care is necessary in design and operation of the furnace to prevent re-oxidation of the sulphide to sulphate.

Washing Beaters Used in Processing Bogalusa Kraft Paper

The quality of the salt cake also is important. Less than 94 per cent of sodium sulphate means poor economy of operation. Silica and iron appear to be the most objectionable impurities, since they retard the rate of settling of the lime sludge, and chromium raises the fusing point if too large a quantity is present. In a mill that used natural salt cake, containing considerable gypsum, it was found that it was reduced to the sulphide, which later reacted with the sodium carbonate in the green liquor, forming the sulph-hydrate. Less lime was needed for causticizing the green liquor, but it would be poor economy to buy salt cake with high gypsum content in order to save lime. It is conceivable, however, that mills with a high lime cost and gypsum available at a low price, might use the latter along with salt cake, especially if the lime sludge is being re-burned.

Clarification of the green liquor before causticizing aids settling of the lime sludge, but it is practiced only in mills that re-burn the latter. Continuous causticizing is a logical development that has not yet become universal. Filter washing of the sludge is, however, common to most mills. Kelly filters are used at Bogalusa, and the rotary type in the other mills. The sludge must be washed clean before re-burning; otherwise, troublesome nodules of lime-soda glass may be formed. Where natural gas is available at reasonable cost re-burning is profitable and convenient, but where oil-firing is necessary the results have been less fortunate. Other means of sludge disposal have not been developed, except where dumping is permissible. The sludge is, however, suitable for numerous purposes such as a sweetener for acid soils and as a filler for asphalt-road materials. For neither of these, however, does the value exceed the cost of preparation and delivery.

Screening and the subsequent operations to which the pulp must be subjected in making it into paper differ from those employed for other fibers only to the extent that these fibers are themselves different. The Southern woods differ from the Northern in making a much larger part of their growth during the summer and autumn. The spring wood forms a much smaller proportion of the total wood. The thick-walled, stiff, coarse summer-wood fibers predominate and give to this pulp certain definite characteristics. Under the microscope the fibers of the Southern pines viewed beside those of the Northern, appear like sticks of stove wood lying among willow switches. Just as the willow wands would form a tighter mat through which the water would drain more slowly, likewise the spruce and Northern pine pulp are characterized by the paper maker as "slower" pulps, while the Southern pine pulps are "freer." These require harsher treatment; consequently the tendency in the South is to rely on jordans almost exclusively and to use larger volumes of water on the paper machines.

The fiber products now manufactured are kraft wrappings, bag papers, gummed tape, fiber containers, and a few specialty products like bristol and stencil boards. With the rapid expansion of manufacturing capacity, there is now an overproduction of these products; hence the higher-cost mills are turning their attention toward the possibility of making other grades. Electrical insulation, greaseproof and twisting are some that may be developed, though efforts in that direction thus far have not been entirely successful.

The suitability of Southern pine as a paper-making material was first demonstrated by cooking a shipment from Gulfport, Miss., at Billingsfors, Sweden. Some of this was bleached and made into high-grade book paper that was 100 per cent Southern pine fiber. Semi-bleached products have been made for special purposes and high-grade alpha cellulose suitable for nitration, esterification, or for viscose has been made on a semi-commercial scale. Recent work at the Forest Products Laboratory has shown that Southern pine pulps can be blended with those made from Southern hardwoods to make special wrappers or papers of higher grade.

Among the other possible future developments is the manufacture of the combination of oleoresins and fiber products. One step in that direction has already been made at Pensacola, Fla., by the Armstrong-Newport Company, which will use extracted stumpwood chips for the manufacture of roofing materials. These extracted chips are not suitable for the manufacture of kraft paper, but some day a process may be worked out for using them to prepare a cellulose suitable for nitration.

Sodium Metasilicate:

Its Place Among Industrial Alkalis

By JAMES G. VAIL
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Philadelphia, Pa.

TWO crystalline hydrates of sodium metasilicate were described by Fritzsche in 1838. Since that time several workers have added to our knowledge of this salt, notably Erdenbrecher, who described additional hydrates and interesting transitions from one to another. All these forms of sodium metasilicate crystallize from mother liquors which are sticky. The crystals are so soluble that satisfactory separations from the mother liquors are not readily accomplished. The difficulty of preparing the salt in suitable commercial form has been the principal obstacle to the consideration of sodium metasilicate as an industrial alkali.

A granular free-flowing product has lately been prepared from a new hydrate (patents applied for). Its composition is $Na_2SiO_3.5H_2O$. Although other hydrates can also be prepared in acceptable form by the same inventions, this one appears for the present to be the most convenient and is the basis of the considerations which follow. In order to appraise the prospect of usefulness of a new industrial alkali it is necessary to become oriented with respect to other available materials and to compare the properties on which uses in industry depend, as well as the relative costs of operations which may be done with its aid.

It will be recognized that this article is written at an early stage of the development of sodium metasilicate as an industrial alkali. Many of its aspects will require extended scientific elaboration which can be developed only over a considerable period of time. While such studies have been undertaken and will, in due course, be published under the names of the appropriate authors, it seems worth while to place at the disposal of chemical engineers such available information as may be of present use to them.

An important group of uses of sodium metasilicate is in connection with various kinds of industrial cleaning. Cleaning is a very complicated process. Dirt to be removed is almost as various as the materials of industry. Although the chemical engineering of detergent operations has not been highly developed and there is no satisfactory method for evaluating cleansers, yet by carefully considering the various factors involved it should be possible to work out a cleansing operation just as effectively as any other engineering process.

When each of these aspects can be given its due weight and applied to the basic alkaline materials of industry, it will be found that sodium metasilicate has a place as one of the tools of the engineer who would put cleaning on a more rational basis.

The principal raw materials of the cleaning industries are soaps, sodium carbonate, bicarbonate and sesquicarbonate, borax, disodium and trisodium phosphates, caustic soda, sodium cyanide, and silicates of soda. It is necessary to a proper understanding of sodium metasilicate to distinguish clearly between it and the more familiar forms of silicates of soda. Although its basic ingredients are the same, its properties and uses are quite different. The preparations usually known as silicates of soda are more or less syrupy, colloidal solutions, anhydrous glasses, or hydrated solids without crystalline form or any tendency under ordinary circumstances to acquire it. The ratio between sodium oxide and silica is indefinite except as arbitrarily standardized by the manufacturers. Properties such as viscosity, drying time, density, refractive index, and pH can be varied over considerable ranges by changing the ratio between alkali and silica without regard to definite stoichiometric boundaries. The ordinary range of composition lies between $Na_2O: 1.5\ SiO_2$ and $Na_2O: 4SiO_2$. These products have extended uses in industry but in ways which

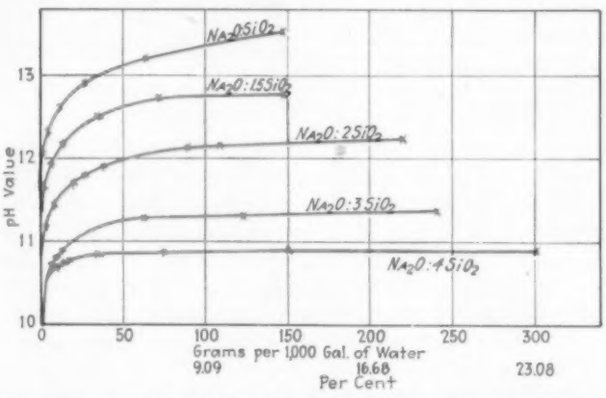

Fig. 1—Effect of Ratio (Na_2:SiO_2) and Concentration on pH of Silicate Solutions

are quite distinct from those of the definite crystalline sodium metasilicate.

$Na_2SiO_3.5H_2O$ is a solid white granular salt which melts in its water of crystallization at 71.8 deg. C. At this temperature or above it is miscible with water in all proportions. At atmospheric temperatures approximately 3 lb. can be dissolved in a gallon of water. Heat is absorbed in the process. The dry salt will lose or absorb some moisture from air within the range of ordinary atmospheric humidity. When moist it will absorb carbon dioxide. The rate at which these reactions take place is such that for most purposes it is satisfactory to pack and ship the salt in wooden barrels, although long

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storage under very moist conditions would make it advisable to use metal containers.

Compared with other soluble silicates the alkalinity of sodium metasilicate is high, both quantitatively and qualitatively, as will be seen in Table I.

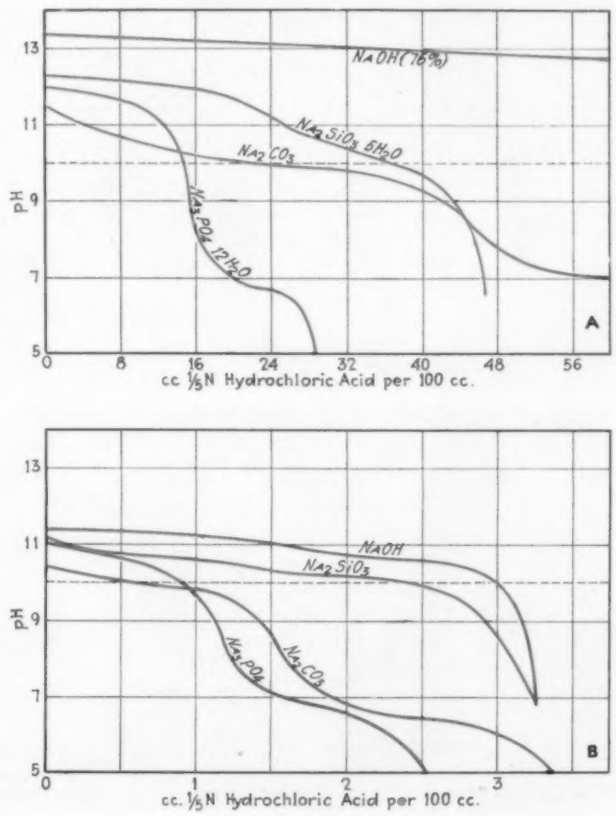
Table I—Composition of Typical Grades of Commercial Silicates

Commercial Grades	Na_2O	SiO_2	H_2O	Percentage Ratio	Molecular Ratio
Metasilicate pentahydrate...	29.3	28.5	41.9	1:0.97	1:1
C 59 deg. Bé.....	18.0	35.9	46.1	1:2	1:2.06
U 52 deg. Bé.....	13.7	32.9	53.4	1:2.40	1:2.47
N 41 deg. Bé.....	8.9	29.0	62.1	1:3.25	1:3.35
S 33.5 deg. Bé...	6.4	24.7	68.9	1:3.86	1:3.98

Consideration of the pH-concentration relationships (Fig. 1) brings out qualitative differences between the various ratios. The pH in each case rises rapidly and approaches a limiting value for that ratio, after which increasing the concentration either fails to raise or even slightly lowers the values. Thus while a metasilicate solution of 0.1 per cent has a pH of approximately 11.2, that value cannot be reached with $Na_2O.4SiO_2$ even in a solution with 30 per cent of solids. Harman's data show 4 per cent solutions of $Na_2O.4SiO_2$ and Na_2SiO_3 to have pH values respectively below 11 and above 13. The value for metasilicate reaches 13.5 below a concentration of 3N.

Sodium metasilicate has a strong buffer action effective at levels above those attainable with any of the more siliceous types of silicate, in fact, at levels above all other industrial alkalis except caustic soda. Most cleaning solutions are, to some degree, spent in the course of their use. Their alkalinity may be reduced by the action of acidic materials, of calcium or magnesium in hard water, or of sodium bicarbonate in soft water. Alkali may also be removed by adsorption on solid dirt or emulsified oils.

Fig. 2—Effect of Titration on pH of Commercial Alkalis
A—One per cent solutions of different alkalis; *B*—solutions containing 0.02 per cent Na_2O.



Buffered cleaning solutions are of value in giving uniform results continuously.

The results of colorimetric titration of comparable commercial alkalis are shown in Fig. 2. The alkalinities are not greatly different in the fresh solution, but as neutralization proceeds, the pH of trisodium phosphate falls off sharply when one-third of its sodium content has been neutralized, and that of sodium carbonate suffers a similar decline on the neutralization of half of its alkali. The intensity of sodium hydroxide, on the other hand, remains high until it is almost completely spent. Between these lies sodium metasilicate, and if a line is drawn at pH 10 it will be seen that much more alkali is available from metasilicate above this value than from either trisodium phosphate or sodium carbonate. The value of 10 is, for many cleansing operations, particularly those in which soap is used, a critical one, below which the action of the solutions is much impaired. At other concentrations different pH levels are attainable but the metasilicate curve lies always above the carbonate and phosphate and below caustic.

A convenient comparison of the amounts of alkali shown by phenolphthalein and methyl orange in various industrial alkalis is given in Fig. 3.

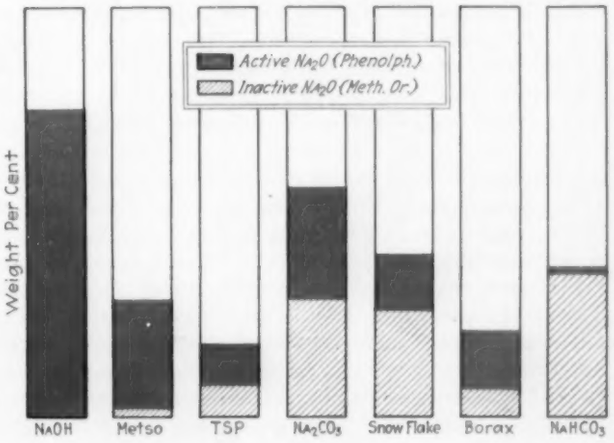
In consideration of the unit cost, it is clear that, as a source of alkali at a high degree of activity, sodium hydroxide is the most economical and that the value of the other materials must therefore rest on a combination of alkalinity with other useful properties. The approximate quantities of alkalis to give pH 10.2 and the pH of 0.1 per cent solutions affords a further basis of comparison.

Table II—Relative pH of Commercial Alkalis

Concentration in Per Cent by Weight Necessary to Give a pH of 10.2		pH of Solutions 0.1 Per Cent by Weight
Caustic soda (Na OH)	0.003	11.8
Sodium metasilicate ($Na_2O.SiO_2.5H_2O$)	0.01	11.2
Soda ash I Na_2CO_3	0.02	10.7
Trisodium phosphate $Na_3PO_4.12H_2O$	0.025	10.9
Sodium sesquicarbonate ($Na_2CO_3.NaHCO_3.2H_2O$)	Over 4.0	10.0

One of the experimental indications, however, that the chemical activity of metasilicate is much less than that of caustic soda is shown in Fig. 4, where equal quantities of sodium oxide in each of the two have been applied for the same time and at the same temperature. The hydroxide solution etched the tin, while the metasilicate left a surface brilliantly lustrous. Five pounds of sodium metasilicate per 100 gal. of water was used. The metal was exposed for ten minutes at a temperature of 60 deg. The experiment is not to be taken to show that metasilicate solutions will not etch tin but rather that the be-

Fig. 3—Active and Inactive Na_2O in Industrial Alkalis



havior of alkali combined as metasilicate is different from the same sodium combined as hydroxide. The concentration chosen, however, has a good cleaning effect.

Cleaning of materials subject to injury by alkalis is often done with relatively strong solutions applied for short times and promptly rinsed away, but even in such practice the permissible concentration, time, and temperature will be greater with sodium metasilicate than with caustic solutions of the same alkaliniity. On a basis of equal weights of the commercial chemicals the contrast is even more striking.

Aluminum cleaning is a case in point: Fig. 5 shows the effect of 1 per cent boiling solutions of the commercial alkalis applied for five minutes to certain greasy aluminum jar caps; similar results were obtained with solutions of the same Na_2O content. In both experiments the metal surface cleaned in metasilicate is bright, while the corrosion by the other alkalis has left the surface dull and gray or white. There was a black residue in the caustic and phosphate solutions, but none in the metasilicate. The corrosive action in this case evidently is not entirely due either to quantity of alkali or pH but has also to do with the influence of the anions. Satisfactory removal of a tallow and tripoli buffing compound from brass parts has been accomplished with an actively agitated boiling 1 per cent solution of sodium metasilicate applied for five minutes during which the surface of the brass was not visibly affected.

Cleaning of soft metals requires discrimination, though satisfactory conditions have been worked out for metasilicate in a variety of industrial problems including tinned cans in dairies, bakers' pans, and packing house products.

FURTHER contrast between the behavior of sodium metasilicate and caustic soda may be brought out by heating cotton cloth moistened with dilute solutions of the various alkalis to temperatures such as those ordinarily reached in ironing washed fabrics. The yellowing of the cotton due to reaction with the alkali and the depreciation of strength are materially less. In one comparison the pieces of fabric, saturated with solutions containing 2 per cent of the commercial alkali, passed through a wringer, and heated two hours to 110 deg. C., gave the strength figures tabulated in Table III.

Table III—Effect of Alkalis on the Bursting Strength (Mullen Test) of Utica Sheeting

Original	168.4	$NaHCO_3$	190.7
Distilled water	184.0	$Na_3PO_4.12H_2O$	194.6
NaOH	169.0	$Na_2SiO_3.5H_2O$	193.7
Na_2CO_3	180.5		

Each figure is an average of at least twelve measurements. The conditions of the test, which, like ironing, permitted the concentration of alkali by evaporation, make the initial concentration of minor significance. Factors other than alkalinity evidently have a bearing on the results, which are offered only to show that in this respect sodium metasilicate falls into the group of milder alkalis.

The trend of modern practice in most detergent operations requiring the use of soap, particularly in commercial laundries, is to work at higher pH levels than was formerly considered advisable. This reduces the hydrolysis of the soap and increases the power to form suds. This suds formation may be due to an ability of the alkali to increase the tendency of soap to concentrate at air-water interfaces and perhaps also at interfaces between oil and water. The subject requires accurate investigation, but every laundryman knows that a pound of soap will do more work in combination with an alkaline builder than it will alone. A simple experiment shows that the ability of alkaline builders to increase the lathering power of soap is different at least in degree.

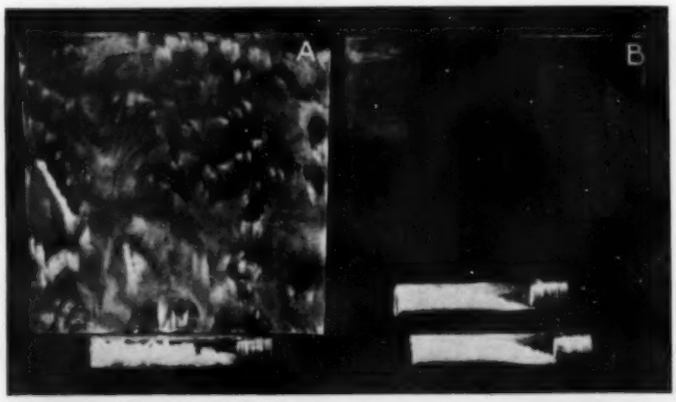
In the series of tubes in Fig. 6, each contains the same quantity of soap and water and, with the exception of the right-hand sample, the same addition of alkaline builder. They were shaken under conditions as nearly uniform as possible and allowed to stand for the same time before being photographed. The soap dissolved in distilled water gave a turbid solution with only the first indications of ability to form lather. The addition of borax did not bring about much change. Sodium bicarbonate caused a large increase of lather, but this is well known to be unstable, as the temperature rises and the bicarbonate breaks down to carbonate. Then in ascending order the quantity of lather increases as sesquicarbonate, soda ash, trisodium phosphate, and metasilicate are added. Sodium hydroxide causes a smaller increase than metasilicate. The conditions of the experiment were 50 cc. of distilled water, two drops of soap solution (100 g. castile soap per one liter of methyl alcohol), 0.375 gram each of commercial borax, bicarbonate, sesquicarbonate, soda ash, trisodium phosphate, metasilicate, and caustic.

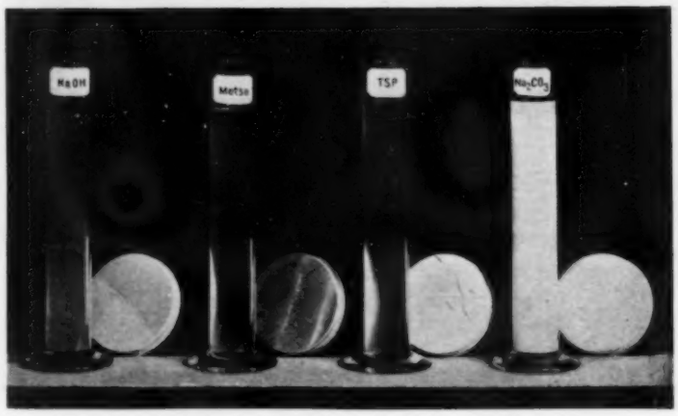
Another experiment consists of titrating 50 cc. portions of 0.2 per cent solutions of the commercial products with standard A.P.H.A. soap solution until a lather is formed sufficiently stable to persist for five minutes. The results are shown in Table IV.

A prevalent method of controlling commercial laundry operations consists in adding built soap solutions until what is judged a sufficient lather has been formed. By

Action of Sodium Silicate Compared

Fig. 4—Tin subjected to equal amounts of Na_2O; *A*, caustic soda; *B*, metasilicate.
Fig. 5—Action on aluminum of equal weights of alkalis (action with equal Na_2O contents is similar).





this method smaller quantities of washing solutions will be employed if the builder is sodium metasilicate, and experience indicates that on this method of control it is possible to do satisfactory cleaning with the advantages of improved color of the work which are known to go along with the use of silicated detergents.

Table IV—Drops of A.P.H.A. Soap Solution to Form Lather

Soda ash	(pH 10.7)	45	Borax	(pH 9.0)	40
Sesquicarbonate	(pH 9.8)	45	Caustic soda	(pH 12.6+)	32
Trisodium phosphate	(pH 11.5)	45	Sodium metasilicate	(pH 11.7)	17
Sodium bicarbonate	(pH 8.2)	40			

Effective washing requires the maintenance of an appropriate pH level so that the extent of building will be regulated by the character of the dirt and the water as well as the sensitiveness of the goods to alkalinity. Zeolite softened water, for instance, often carries so much sodium bicarbonate that a large addition of metasilicate is needed to maintain an effective pH. When it is considered that sodium metasilicate has marked detergent properties of its own with respect to deflocculation, emulsification, and wetting power and that its cost is much lower than that of soap, it will be seen that the combination has interesting possibilities, and this has been proved in practice. Though the ratio between soap and silicate necessarily varies, it may be pointed out by way of example that a mixture of equal parts by weight of soap and metasilicate for washing white cotton goods has been found satisfactory in commercial operation.

Silicates of relatively high silica ratio have been used in laundering and the literature abounds with reference to the accumulation of a siliceous ash in the fabric. Under normal conditions this is very small, but in the case of sodium metasilicate it does not occur at all. Numerous tests of goods washed twenty times in soap solutions built with metasilicate show no measurable increase of ash. Sodium metasilicate is very soluble and is much more easily rinsed out than soap. Plant experience has often shown the possibility of reducing the amount of rinsing with metasilicate builder as compared with practice based on other alkalis.

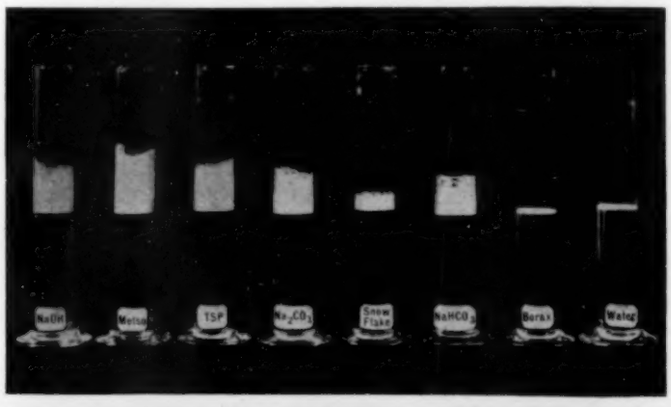
It should be pointed out that bicarbonate should never be added to mixtures or solutions containing silicates, as a reaction ensues which produces normal carbonate and reduces the stability of the silica in solution. The improved effects on color produced by soaps built with sodium metasilicate are, in part, due to a protective action which prevents the redeposition of solid dirt upon clean fabric, and in part due to a better cleaning effect which consists of intensifying the action of soap and reducing the danger of deposit on the fabric of products formed by hydrolysis or precipitation from the soap itself. The color of dyed fabrics is, as a matter of experience, also consistently brighter when a silicate builder is used. The investigation of these subjects is well advanced and the results will, in due course, be published.

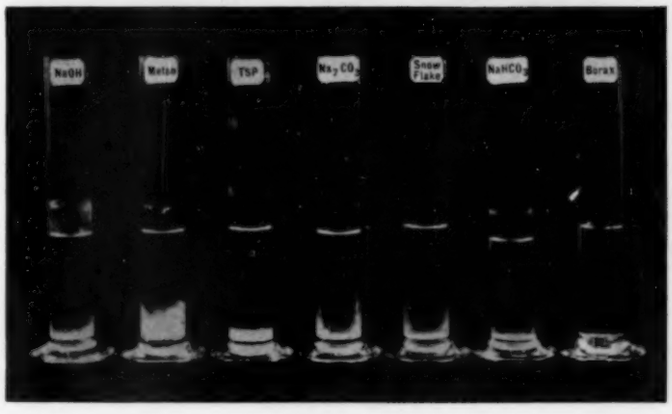
A special case of laundering, which can be well done with metasilicate without the aid of soap, is the reclaiming of oily rags or cotton waste used in machine shops, or the cloths stained with paints or nitrocellulose lacquers in such plants as finish automobile bodies, furniture, and the like. The washing of soiled rags as the first step in making high-grade papers and the de-inking of printed paper stock also give impressive evidence of the detergent value of metasilicate solutions.

With Various Commercial Alkalis

Fig. 6—Influence of various alkalis on lathering power of soap.

Fig. 7—Reaction products of various alkalis with hard water.





IN general, the cleansing materials required in the food industries are more vigorous in action than those applicable to the laundering of clothing. Exceptions are found in cases where the dry salts must come in contact with wet human hands and where metals such as aluminum must be cleaned with a minimum of corrosion and without close control of working conditions. The cleaning of milk bottles is a case in which strong alkaline solutions are customarily employed. This work is done in machines of various types, using jets, brushes, or conveying the bottles through tanks of hot alkaline solution. The latter type is frequently charged with caustic soda or mixtures of caustic and soda ash, and the concentration is maintained by titration at levels from 2 to 4 per cent.

The substances to be removed in washing milk bottles include casein and albumin, in addition to fat and water-soluble substances from milk, and a great deal of miscellaneous dirt from extraneous sources. Before refilling, the bottles should be clean and sterile. A chlorinated rinse generally is used, but it is desirable to destroy as many bacteria as possible in the course of washing. The typical appearance of the milk bottle washed in a caustic solution as it comes from the machine is a misty or cloudy one, due to small drops of water which stand upon the glassware.

In a certain instance a machine with five tanks, maintaining a concentration of 3 per cent Na_2O in the first two, was washing 100,000 bottles with an addition of 140 lb. of flake caustic soda daily. A pound for pound substitution of the caustic soda with metasilicate produced a lower concentration of alkali but a cleaner bottle on which no drops of water stood up. The glass was evenly wet and completely brilliant. The concentration of the metasilicate was then gradually reduced with careful observation, and clean brilliant bottles were still obtained

when the concentration had reached 0.3 per cent Na_2O, one-tenth of the previous amount. For a week, satisfactory results were obtained with the daily addition of 50 lb. of metasilicate in place of the 140 lb. of caustic soda. In order to insure suitable margin of safety a daily addition of 70 lb. was adopted.

Preliminary results show that the ability of sodium metasilicate solutions to destroy bacteria is high, even at low concentrations indicated by cleaning results, and that metasilicate-caustic mixtures are more effective than any combination of caustic with other alkaline salts heretofore investigated for bottle cleansing purposes.

Whether tested with spore suspensions or vegetable bacteria at 60 deg. C., the killing time is shorter than that of carbonates or phosphates, though somewhat longer than that of caustic. This action is dependent on time, temperature, pH, and specific anion effects. The condition of milk bottles and soft-drink bottles coming through actual plant conditions in various places has been found satisfactory (personal communication, Dr. R. P. Meyers, National Dairy Products Corporation; J. R. Hall, Thesis, Iowa State College, 1930).

A FACTOR of importance in this type of washing is the effect of the alkalis on hard water, which may make trouble in the form of incrustations on the machinery. The difference in the behavior of different alkalis is readily brought out by experiment, as in Fig. 7. A series of tubes contains calcium chloride solutions made up to represent water with 20 grains of hardness. To each tube was added twice the quantity of alkali needed to soften the water. The tubes were placed for 16 hours in an oven at 90 deg. C., after which 10 cc. of liquid was removed from each tube with a pipette, thus exposing the adherent precipitates. Caustic soda formed a hard crystalline adherent deposit. All the carbonates produced adherent deposits, which, in dairy cleansing, are believed to be an important element in the formation of the troublesome incrustation known as milk stone. The deposit from trisodium phosphate was more colloidal and less adherent but relatively dense, while the deposit from the metasilicate was light and flocculent, with no tendency to adhere.

Parker and Johnson (1930 meeting Int. Assn. Milk Dealers) found that deposited milk films hold precipitates from hard water and alkaline cleansers and thus form milk stone, but the reaction products of sodium metasilicate do not adhere and become involved in the milk film as do those of other alkalis.

By actual experience it has been found that washing machinery of various types such as dish washers, bottle machines, and metal washers, which have become incrusted with reaction products of hard water and other alkalis, not only fail to accumulate such deposits when sodium metasilicate is used with the same hard water but the old scale tends to soften and come off.

Caustic soda tends to dull the surface of glassware by a process of etching which is not experienced with the milder alkalinity of metasilicate. The ability of the metasilicate to better wet the surface appears to be related to the presence of some colloidal material in the relatively dilute solutions used. Trisodium phosphate is better than caustic soda in this respect. The removal of the last traces of grease seems to be a function of wetting power rather than chemical activity, which perhaps accounts for the good cleaning obtainable at low concentrations of metasilicate. The action in producing brilliant surfaces is not yet wholly understood.

THE HEAVIEST industrial cleaning usually is concerned with the removal of mineral oil. Strong alkaline solutions are used, generally with additions of rosin or other soaps, although most machines for washing parts by a cascade principle require detergents which do not foam. Metasilicate solutions are of this type and with them it has been found possible to work at such low concentrations that economies over other reagents are experienced.

A particularly difficult job is the cleaning of garage floors, because they cannot be maintained at high temperatures and the oil is difficult to emulsify. The best cleaner for this work consists of 90-95 per cent metasilicate with 5-10 per cent of low titre soap.

Cleaning which consists primarily of removing oil depends to some extent on emulsifying power. Sodium metasilicate makes stable oil-in-water emulsions with many oils which are of mineral origin. When they are completely free of saponifiable or unsaturated bodies, the ability of the metasilicate to disperse them and keep them from forming masses on the surface of the water solution is materially helped by the presence of some soap. In hot solutions for metal cleaning, rosin is effective. The quantities required are small; as little as 1 per cent of rosin based on the metasilicate is useful and for some work sufficient. The action of small quantities of soap in metasilicate may be due to the same causes as the power to form suds: the metasilicate may cause an increase of soap concentration at the interface of oil and water.

At first thought it might be supposed that where an electric current is used to promote the action of an alkaline cleanser metasilicate would give trouble from a separation of silica at the anode. At high concentrations such a separation may take place, but under the conditions of current density and concentration used for cleaning metals the difficulty has not been encountered and satisfactory cleansing has been obtained under a variety of plant conditions. Metasilicate has been found useful in baths with cyanide used to make strike coatings of zinc and cadmium.

Although the best results in metal cleaning have been attained with metasilicate solutions without admixture, except for soap, as already mentioned, it will be clear to those skilled in the art that the so-called soft metals, especially where exposure to the cleaning liquor is long or the temperature high, will require lower pH levels and make the addition of other suitable buffer salts desirable. Sodium silicates with higher silica ratios than metasilicate are useful for this purpose as well as for protective action due to their film-forming properties.

Sodium metasilicate will find uses outside the cleaning industries. It is a good solvent for casein and other proteins, which should make it a useful component of coating mixtures and adhesives; its deflocculating power suggests that it may help in the differential flotation of ores; it is the most convenient source of silica in solution from a dry, easily soluble product. Its specific reactions, as yet but little explored, may extend the possibilities of preparing insoluble silicates for such uses as cements, glazes, and heavy metal silicates for colors or reagents with properties different from other available compounds, but these can be treated only in a later chapter.

The author wishes to acknowledge his debts to the technical staffs of the Philadelphia Quartz Company at California and Philadelphia, on whose work he has drawn freely in preparing this paper.

Hydrogenation Adapted to the Oil Refinery

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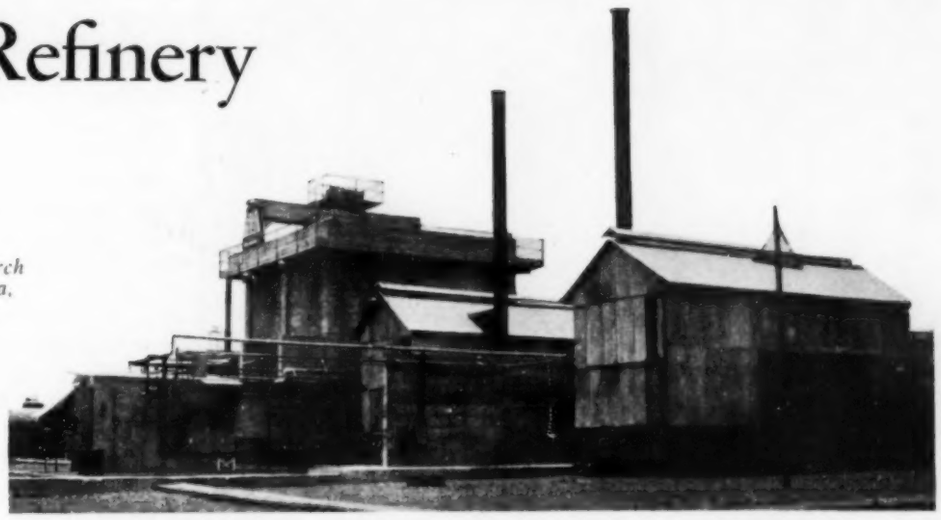


Fig. 1—Hydrogenation Pilot Plant Operated Experimentally at Baton Rouge

ABOUT three and one-half years ago, the Standard Oil Company (N. J.) through its development company, joined with the I. G. Farbenindustrie in the further development and commercialization of the hydrogenation process. As a result, high-pressure laboratories were erected at the Baton Rouge refinery of the Standard Oil Company of Louisiana for the development and study of hydrogenation. The previous development work of the I. G. was applied primarily to the conversion of coal, lignite, tars and asphaltic crudes into gasoline and other light fractions. While experimental work along these lines was continued at Baton Rouge, attention was also given to the broadening of the process in its application to the oil industry.

At first, all of the experimentation at Baton Rouge was carried out in small-scale equipment of approximately ½ bbl. per day capacity. This work, however, indicated many possible adaptations of hydrogenation and led to the design and erection of a semi-commercial plant of approximately 100 bbl. per day capacity for operation at approximately 3,000 lb. per sq.in. pressure. With equipment of this size it was possible to study the process on a scale more nearly approaching commercial operation; and at the same time, to obtain engineering information and operating experience. This pilot plant, since its completion about two and a half years ago, has been operated on the various applications of the process continually, with the exception of short shutdowns for inspection, repairs or slight alterations of equipment. Uninterrupted runs of approximately three months' duration have been made with this plant. These runs were terminated voluntarily for inspection of equipment. Photographs showing various views of the small-scale equipment and of the pilot plant are presented in Figs. 1 to 5, on this and succeeding pages.

Hydrogen for the entire laboratory requirements is manufactured on the site in a semi-commercial scale plant. This plant has also supplied valuable engineering information and operating experience. Both natural and refinery gas have been used in the plant for the production of hydrogen. A view of the gas plant is shown in Fig. 6.

Fig. 2—Operating Panel for Pilot Plant

This development and research program has made technically possible the design of full-scale commercial equipment. There are now in operation, or in process of construction, in the United States three full-scale hydrogenation plants each of approximately 5,000 bbl. per day capacity. Full-scale operation of the process has been an established fact at the Bayway refinery of the Standard Oil Company of New Jersey since the middle of the year. In addition to the Bayway plant, two further plants are in process of construction: one at the Baton Rouge refinery of the Standard Oil Company of Louisiana, and the other at the Baytown refinery of the Humble Oil & Refinery Company. The Baton Rouge plant will be completed and placed in operation in the early spring, and the Baytown plant in the middle of the coming year.

While the hydrogenation process has many applications, the flow of materials is generally similar. Hydrogenation, as applied to petroleum, consists in bringing hydrogen in contact with the materials to be

Presented on Dec. 9, at the New Orleans meeting of the American Institute of Chemical Engineers, under the title, "Applications of Hydrogenation in Oil Refining."

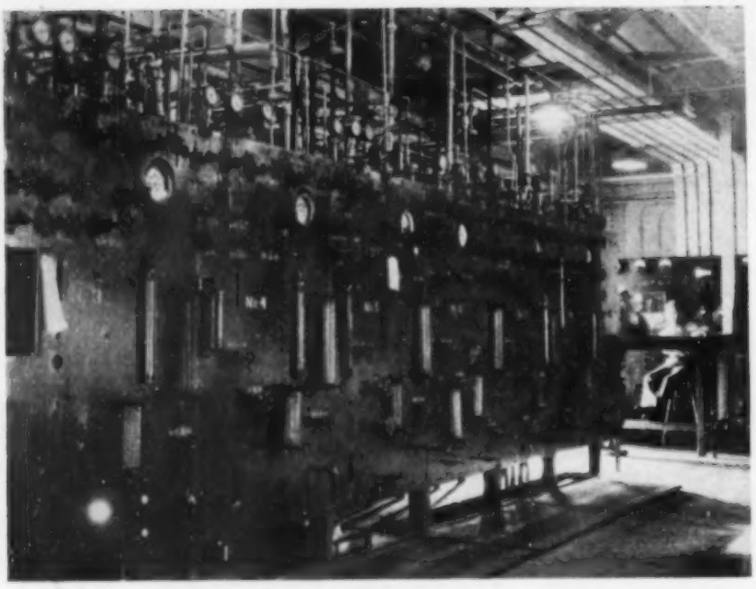


Fig. 3—Operating Panel for Small-Scale High-Pressure Equipment

hydrogenated, under the proper conditions of pressure and temperature in the presence of catalysts, permitting the reaction to occur, and then cooling the reaction products and separating the liquid from the unused gas.

Hydrogen may be produced by any of the known methods, such as: electrolysis of water, or by the reaction between steam and either solid carbonaceous materials or hydrocarbon gases. The selection of the method, naturally, depends upon the economic conditions in existence at the site of the proposed plant. Because of the fact that the hydrogenation catalysts used in this process are not poisoned by sulphur compounds or similar materials, as are the catalysts used in ammonia manufacture or vegetable oil hydrogenation, hydrogen of a high degree of purity is not required. The usual existence of refinery or natural gas in refinery areas makes the use of such gases desirable in the production of hydrogen. The manufacture of hydrogen from these materials may be accomplished by their reaction with steam, the final products being hydrogen and carbon dioxide. The carbon dioxide can be easily removed by water scrubbing or other known methods, thus producing hydrogen of sufficient purity for use in the process. The reactions referred to above are promoted by the use of suitable catalytic materials.

Fresh hydrogen gas is pumped into the system at a pressure of approximately 3,000 lb. per sq.in. and mixed with unused gas recycled by booster compressors. The mixed gases and the oil to be treated pass through suitable heat exchange equipment and into the heating coil where they are preheated to the desired temperature. The oil and gas mixture after preheating is introduced into the reaction chamber in the presence of suitable catalytic material. The products of the reaction and the unused gas are passed through heat exchange equipment, where a large part of the heat is given up to the incoming mixture, and then to a final cooler. After the cooler, separation of the liquid products from the unused gas is accomplished in a high-pressure separator. From this separator the liquid is withdrawn to atmospheric pressure and the unused gas, still under pressure, is scrubbed, if necessary, and recirculated to the fresh gas stream. The subsequent handling of liquid products depends upon the purpose for which they are intended.

Sulphur compounds present in the incoming stock are very largely converted into hydrogen sulphide by the hydrogenation reaction. The presence of small amounts of dissolved hydrogen sulphide in liquid products obtained from the system usually make it desirable to submit them to slight caustic wash or other methods of scrubbing.

From this brief description the process is seen to be relatively simple. Experience has shown that close temperature control is readily obtainable while freedom from coke formation makes operation practically continuous. Catalysts have been developed which are extremely rugged and are uninjured by such materials as hydrogen sulphide and carbon monoxide, which have hitherto presented serious difficulties to hydrogenation processes utilizing the better known catalytic materials.

Some Aspects of the Process—It is important to emphasize that the process, as described, lends itself to the various applications, believed to be of primary interest to the oil industry. It follows that it is possible for the refiner to alter the type of operation to meet his particular needs or market requirements with freedom from long, costly shutdowns for mechanical changes.

Haslam and Russell (*Ind. Eng. Chem., 22,* 1930, 1030) have indicated the further advantages resulting from the flexibility in application of the process, in that large-capacity units become desirable with the possibility of decreased costs, due to increased capacity. Furthermore, the probability of rapid obsolescence is reduced by the manifold adaptations to which the process can be efficiently applied to meet changing market and crude conditions.

FIVE major applications of the process believed of immediate interest to the oil industry will be reviewed briefly. These have been previously presented by Haslam and Russell (*Oil & Gas Jour., 28, 29, 32,* 1930). These adaptations are:

1. The conversion of heavy, high-sulphur, asphaltic crude oils and refinery residues into gasoline and distillates low in sulphur and free from asphalt, without concurrent formation of coke.
2. The alteration of low-grade lubricating distillates, to obtain high yields of lubricating oils of premium quality as to temperature-viscosity relationship, Conradson carbon, flash and gravity.
3. The conversion of off-color, inferior burning oil distillates or light gas oils into high-gravity, low-sulphur, water-white burning oils of excellent burning characteristics, with gasoline being the only other product except for a slight gas formation.
4. The desulphurization and color and gum stabilization of high sulphur, badly gumming cracked naphthas.
5. The conversion of paraffinic gas oils into low sulphur, gum and color stable, good anti-knock gasolines without the production of coke or tar.

These applications of the process are further discussed in the following paragraphs.

Conversion of Refinery Residues—This adaptation of the process accomplishes the conversion of heavy asphaltic, high sulphur crudes and refinery residues into gasoline and gas oil, without coke formation. In addition 65 to 85 per cent of the sulphur is eliminated as hydrogen sulphide. Furthermore, the gasoline thus formed, because of its low sulphur content and gum stability, may be made to meet specifications with only a small amount of finishing. The remaining gas oil fractions are also low in sulphur and lend themselves readily to the formation of additional gasoline by cracking or hydrogenation.

The process may be operated so that the feed stock is converted into 100 volume per cent or more of liquid products containing in the neighborhood of 5 to 35 per cent gasoline with the remaining material boiling in the gas oil range. The gasoline yield may be increased by the recycling of the gas oil to the same unit or by the subsequent hydrogenation of the gas oil in separate equipment.

The formation of gasoline by the present cracking methods is accompanied by the formation of coke and tar. In other words, the upbuilding of the lighter fractions into gasoline is accomplished at the expense of degrading other fractions into tar and coke. In contrast, the formation of gasoline by the hydrogenation of heavy asphaltic materials is accompanied by an upgrading of the entire feed stock. In fact, by recycling operation, as previously indicated, it is possible to upgrade the entire feed stock into gasoline, with gas as the only byproduct.

It is seen that this adaptation of the process offers promise to the refiner in meeting the problem of fuel oil overproduction. By combinations of this operation with cracking it would be possible to control the fuel oil production as desired.

Improvement of Low-Quality Lubricating Stocks—It has been found that the hydrogenation process can effect marked improvement in lubricating distillates. Characteristics of prime importance in good motor oils today are high viscosity index* (indicating a flat temperature-viscosity relationship), high flash, and low Conradson carbon. While some of these characteristics are obtainable in natural lubricating distillates it has not been found economically possible by present refinery methods to combine all of the qualities to the extent desired. By hydrogenation, however, it is possible to produce paraffinic type lubricating oils having desirable temperature-viscosity relationships and unusually high flashes as well as low Conradson carbon. This comparison may be more readily appreciated by consideration of Table I, which shows the inspections of three S.A.E. 30 specification motor oils. The first inspection tabulated is for an oil produced by the hydrogenation of a Mid-Continent stock, while the second and third are for oils produced by the usual refinery methods from Pennsylvania and Coastal stocks, respectively. The combination of high viscosity index, high flash, and low Conradson carbon in the hydrogenated oil is evident.

Operation of the process on lubricating distillates usually results in volumetric yields of 103 to 104 per cent based on the feed. The hydrogenated product, depending upon the feed stock and operating conditions selected, may contain 60 to 85 per cent lubricating oil with 5 to 10 per cent gasoline and 10 to 30 per cent gas oil. The lubricating oils produced are very low in sulphur; usually 80 to 90 per cent of the sulphur in the feed is eliminated.

Of particular importance to the refiner is the fact that excellent quality motor oils can be produced from a wide variety of crude stocks, thus making posible the selection of such stocks which will not burden the refinery with highly paraffinic gasolines of poor anti-knock properties resulting from the use of paraffinic crudes.

Conversion of Inferior Burning Oils—As would be expected from the discussion of lube oil improvement, inferior quality burning oils respond easily to treatment by hydrogenation. Feed stocks such as California, heavy Mid-Continent, and coastal distillates are made to yield burning oils of a quality equal to Mid-Continent and Pennsylvania straight-run products. Elimination of as high as 98 per cent of the sulphur in the feed stock has been accomplished in some instances, so that after reduction to viscosity and flash, a marketable product is obtained without further finishing except possibly a slight doctor treat.

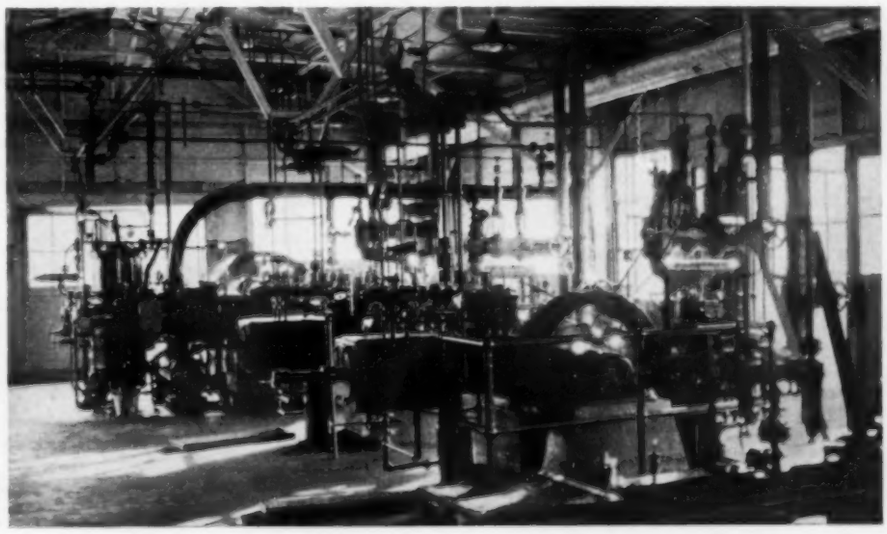
In this application of the process, as well as those previously described, volumetric yields of hydrogenated product in excess of 100 per cent are obtainable. One hundred barrels of feed stock yield 103 to 105 bbl. of product containing 65 to 85 per cent of high-quality burning oil with the remaining product a low-sulphur, gum-stable gasoline having an anti-knock value equivalent to that of gasoline produced by cracking Mid-Continent gas oil. Inspections of representative products from this type of operation are shown in Table II.

In comparing this application with extraction methods for the improvement of kerosene, it should be borne in mind that while extraction methods improve only the fraction in the feed stock meeting flash and viscosity specifications, the hydrogenation process actually increases the amount of the burning oil fraction when suitable boiling range feed stocks are selected. For example, a feed stock containing 40 per cent of a burning oil fraction with some higher boiling products will yield 60 to 80 per

Table I—Comparison of Hydrogenated Lubricating Oils With Those Produced by Usual Methods

	From Hydrogenated Mid-Continent Stock	By Usual Refinery Methods from Pennsylvania Crude	By Usual Refinery Methods from Costal Crudes
Gravity A. P. I.	29.8	28.8	19.6
Viscosity @ 100°F.	440	447	533
Viscosity @ 210°F.	62	62	53
Viscosity Index	109	104	0
Flash °F	490	425	370
Color (Robinson)	15	3	10
Conradson Carbon %	0.010	0.62	0.06

Fig. 4—Compressor and Pump House for Pilot Plant



*The term "viscosity index" was devised by Dean and Davis, *Chem. & Met. Eng.*, 36, 618 (1929), and indicates the temperature-viscosity characteristics of lubricating oils.

cent of high-quality kerosene, with gasoline as the only byproduct.

The low sulphur content of the kerosene produced makes the product of exceptional value to the refiner for blending off higher sulphur-containing fractions from other sources.

Finishing of Naphthas—The treating of high-sulphur cracked naphthas by hydrogenation for sulphur removal, gum stabilization and color improvement is another important application of the process. The usual treating methods for cracked naphthas in use today are rather costly, resulting in appreciable treating losses and a decrease in anti-knock values in the finished gasoline. By the use of hydrogenation it is possible to eliminate upward of 50 per cent of the sulphur in such feed stocks as West Texas naphthas, with a resulting gum stable and marketable-color product with only a slight decrease in anti-knock value. This operation can be so controlled that no alteration in boiling range occurs and 100 per cent volumetric yields are obtained.

By slight alteration in operating conditions it is possible to take cracked naphtha distillates containing some fractions boiling above the gasoline range and convert them into low-sulphur, gum-stable, specification-color gasolines improved in knock-suppressing value. This type of operation is accompanied by some loss to gas so that volumetric yields of 90 to 95 per cent are obtained. The resulting product, however, is greatly altered in boiling range and the fill is such that need for casinghead is greatly reduced or eliminated. Inspections of products obtained by the hydrotreating operation are shown in Table III.

Hydrotreating of cracked naphtha should be of real value to the refiner, not only in the finishing of high sulphur distillates which react stubbornly to present treating methods, but also in the general improvement in quality of products and the reduction or elimination of the need for casinghead for blending purposes.

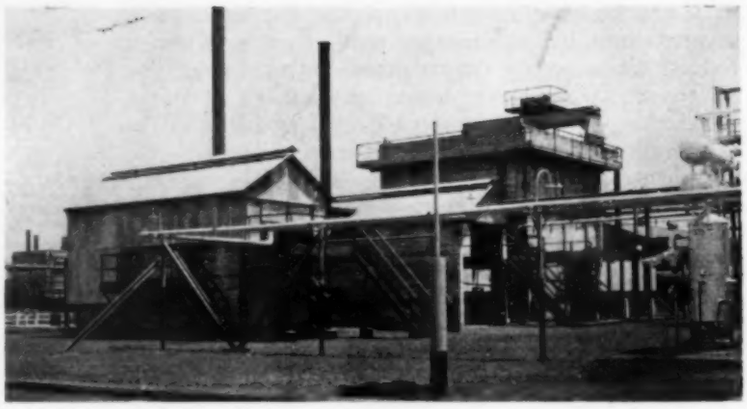


Fig. 5—Another View of Pilot Plant

Production of Anti-Knock Gasolines—With the trend of motor car manufacture toward high-compression engines the production of gasolines having high knock-suppressing ability is assuming a position of ever-increasing importance. Strange as it may seem, after the mention of the previous adaptations of the hydrogenation process in which the products were usually more paraffinic than the feed stocks, hydrogenation offers a method for producing gasolines having excellent anti-knock properties from paraffinic gas oils. From less paraffinic feed stocks, gasolines with even better anti-knock properties are obtained. Furthermore, this type of operation can be carried out in the same apparatus as used for the other applications without mechanical change. For example, the experimental pilot plant has been run on a paraffinic stock to produce high-quality kerosene and subsequently, by alteration only of operating conditions, to produce low-sulphur gasoline with an anti-knock value equivalent to 80 per cent iso-octane in n-heptane, from the same feed stock without interrupting operation.

In the operation of the process for anti-knock gasoline production, fractions boiling above the gasoline range are recycled, thus making gasoline and gas the only products. No coke or tar is formed. Because of appreciable gas formation the volumetric yields are usually in the range of 85 to 95 per cent when highly anti-knock gasolines are produced. When knock rating is not important, yields of approximately 100 per cent can be obtained. Anti-knock gasolines produced by hydrogenation require very little, if any, treatment to render them of marketable quality. Examples of inspections of anti-knock gasolines produced by the hydrogenation process are shown in Table IV.

From this tabulation it is seen that gasolines of unusually high knock-suppressing value have been produced. Furthermore, it may be noted that the type of feed stock influences the anti-knock quality of the gasoline formed. Thus, while excellent anti-knock gasoline can be produced from paraffinic stocks, equal yields of gasoline having even better anti-knock properties can be produced from less paraffinic gas oils which are usually considered more refractory and less easily processed by cracking equipment.

The advantages of the hydrogenation process, for the production of anti-knock gasolines with its freedom from

Table II—Hydrogenation of Burning Oil Distillates

Feed Stock	Low Grade Mid-Continent	Colombia
Gravity—A.P.I. Deg.	40.2	36.1
Viscosity*	485	600
Sulphur—Per Cent	0.221	0.202
"400" Vis. Oil† in Original (Per Cent)	58	30
A.P.I. of "400" Vis. Oil	41.2	38.9
Product		
Volumetric Recovery‡	105	101.7
A.P.I. of Total Product	49.0	52.9
Sulphur of Total Product (Per Cent)	0.008	0.01
"400" Vis. Oil in Total Product (Per Cent)	85	60.8
A.P.I. of "400" Vis. Fraction	46.2	45.5
Vis. of "400" Vis. Fraction	400	358
Sulphur—Per Cent	0.008	0.005
Flash °F. (Abel)	104	109
Color (Saybolt)	21	20
Sulphur Elimination (Per Cent)	96.0	95
Improvement in A.P.I. of "400" Vis. Fraction	5.0	6.6

*Saybolt Thermo Refined Oil viscosity @ 60°F.
†The term "400" Vis. Oil denotes the fraction of about 400 vis. and above 100°F. Abel flash.
‡Not including a small yield of recovery naphtha produced concurrently.

Table III—Treating Light Distillates by Hydrogenation

Feed Stock	Cracked Smackover Distillate	Cracked West Texas Distillate
Gravity—A.P.I. Deg.	46.4	39.3
Initial	.....	262
Per Cent @ 212	14.5	.....
Per Cent @ 284	35.0	.....
Final Boiling Point	550	451
Sulphur	0.40	0.11
Dissolved Gum	12	65.1
Anti-Knock Value as Iso-Octane in n-heptane	66	61
Product		
Yield (Per Cent)	99.0	90.0*
Gravity—A.P.I. Deg.	52	48.2
Initial	136	117
Per Cent @ 212	11.5	27.5
Per Cent @ 284	37.5	62.0
Final Boiling Point	504	391
Sulphur	0.02	0.008
Dissolved Gum	1	3.1
Iso-Octane in n-heptane	63	72.3

*Plus about 2 per cent bottoms, 450 End Point.

Table IV—Production of Anti-Knock Gasolines by Hydrogenation

Feed Stock	Virgin Mid-Continent Gas Oil			Cracked West Texas Gas Oil		Calif. Cr. Gas Oil	
Gravity—A.P.I. Deg.	37.8			30.8		25.7	
Initial	424			404		34.2	
Per Cent @ 460	5.0			57.0		31.0	
Per Cent @ 500	43.0			85.5		68.0	
Per Cent @ 550	85.0			95.0		91.0	
Per Cent @ 700 or Final Boiling Point	613			602		602	
Sulphur	0.170			0.182		0.554	
Aniline Point—°F.	159			106		79	
Hydrogenated Product							
Yield—Per Cent by Volume	92.2	88.3	86.8	92.3	90.9	89.3	79.0*
Gravity—A.P.I. Deg.	54.3	56.0	61.8	40.1	43.5	50.0	42.6
Initial	85	96	88	108	106	97	114
Per Cent @ 212	30.0	32.5	40.5	15.0	19.0	23.0	15.0
Per Cent @ 284	47.5	53.5	77.0	26.5	34.5	45.5	44.0
Per Cent @ 356	66.0	74.5	.....	44.0	61.0	85.5	80.0
Per Cent @ 374	71.0	81.5	.....	53.0	73.0	93.0	87.5
Per Cent @ 400 (or 90 per cent off)	415	393	313	73.0	390	364	382
Final Boiling Point	430	403	336	428	404	376	426
Knock Rating as Per Cent							
Iso-Octane in n-heptane	69.8	73.8	77.5	83.0	87.8	85.8	92†
Dissolved Gum	5.2	2.3	6.4	8.2	3.5	3.0	2.6
Sulphur	0.035	0.015	0.023	0.007	0.010	0.019	0.028

*This yield does not include recoverable light ends.
†Extrapolated.

coke and tar formation, and its ability to produce low-sulphur, gum-stable, high anti-knock gasolines relatively independent of type of feed stock, in comparison with those of the present methods of cracking, are evident.

Consideration of the five adaptations of the hydrogenation process, briefly reviewed above, indicates that the process may accomplish a decrease or an increase in paraffinic character of the products as desired. It is possible to make paraffinic kerosene or an anti-knock gasoline by the alteration of operating conditions such as temperature and hydrogen concentration. Thus, the process presents the possibility of altering the carbon-hydrogen ratio and influencing the molecular structure of various petroleum fractions, at the same time removing undesirable sulphur compounds. In the terms of the oil refiner, this means that it is possible to:

(1) Balance white products with fuel oil production as demanded by market conditions.

(2) Maintain or improve quality of products relatively independent of type of crude supply.

(3) Meet market requirements for changing products, such as more highly anti-knock gasolines or special Diesel fuels as progress in the mechanical field continues.

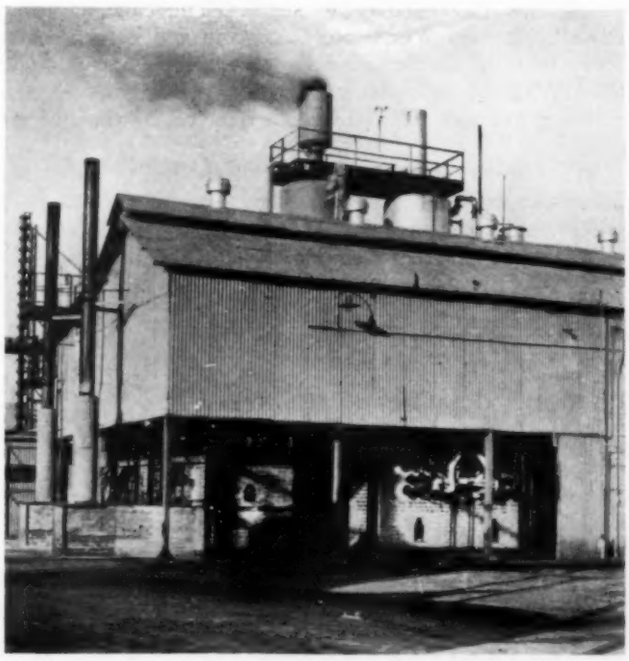
(4) Reduce or eliminate many of the refiner's present treating problems.

A consideration of more widespread interest is the increased efficient utilization of petroleum supplies available, with an overall improvement in quality of products.

In conclusion it may be said that it is not expected that hydrogenation will immediately replace present refinery methods, but rather, that the application of the process to the oil industry will result in (a) balanced refinery operation by controlling the production of such byproducts as fuel oil and residues, (b) reduction of treating problems, and (c) improvement of product quality more or less independently of type of crude supply.

The author wishes to acknowledge his indebtedness to his associates in the Development and Research Department of Standard Oil Company of Louisiana and to the many others with whom he has been associated in the development of the hydrogenation process.

Fig. 6—Experimental Hydrogen Production Plant



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British Solvents Enterprise Materializes

TWO years ago it was intimated in the *Chemical Age* that the Distillers Company at Great Burgh, Epsom, England, contemplated an early entry into chemical industry as manufacturers of industrial organic products, starting with alcohol. It was further suggested that synthetic processes, involving catalytic treatment and high pressure methods, might be employed on a large scale.

Within that time, these ideas have been converted into commercial practice on a scale so large as to be almost incredible, according to a comprehensive account in the *Chemical Age* of Sept. 27, 1930. At Saltend, about five miles out of Hull, on an extensive site occupying some 45 acres, a series of great works have been brought into existence which are already producing on a large scale and are still being enlarged by the construction of additional plants. The operations fall into three sections, all under unified control and governed by a central purpose. The oldest contains the works of the Hull Distillery Company, which produces alcohol from molasses.

The supply of molasses, from Java, is pumped into tanks in the works and undergoes the normal fermentation and distillation by which practically pure spirit is recovered, which is passed as raw material into the other two sections. The first of these is the immense vinegar factory owned by the Distillers Company, Ltd., comprising nearly a thousand acetifiers wherein the biological process of converting alcohol to vinegar is carried out under the most modern conditions. The other is the newly constructed plant of British Industrial Solvents, Ltd., a company in which the Distillers Company, Ltd., has in partnership the Holzverkohlungs-Industrie G.m.b.H. of Konstanz, in whose laboratories these processes have been evolved. In one section of the works the alcohol, after being denatured, is converted into acetone. In another it is oxidized to acetaldehyde, which serves as an intermediate for the production in one direction of crotonaldehyde, leading to crude and finished butanol, and in another to crude and finished acetic acid.

Chemical Engineering Advances In the CANE SUGAR

By GEORGE P. MEADE

Colonial Sugars Company
Gramercy, La.

IT SEEMS safe to say that few, if any, industries are more dependent upon chemical engineering than is the production of sugar. With a highly developed and specialized technology relying on chemical control, it employs a majority of the unit operations of chemical engineering. The scope of the industry also makes it of particular interest since it involves huge agricultural operations, the manufacture of a raw product, large-scale refining of that product, and an elaborate distribution system. In the beet industry these operations are almost always localized under one head. This is not generally true in the cane-sugar branch of the work, the cane growing and raw sugar production of necessity being in the tropics or semi-tropics, while the refining and selling branches are located in the larger seaports near the big markets. A few raw sugar mills have refineries in conjunction with them and direct production of refined sugar by vegetable carbons on plantations undoubtedly is on the increase, but for the present, the prestige of the boneblack refineries located in strategic distribution centers is not seriously threatened.

Chemical engineering advances in the cane-sugar industry, both in raw-sugar manufacture and refining, in the last 10 or 15 years have been largely of degree rather than of kind, since few radical departures have been made on a broad scale in either field, with the exception of the clarification station in the raw-sugar house and the defecation system in the refinery.

A modern train of five or six sets of three-roller mills with crushers, carriers, housings, bedplates, and driving mechanism constitutes one of the largest combinations of machinery in any industry, but except in the matter of size, strength, power, and number of rolls, there has been little change in the mills themselves in over 30 years. The grooving of the mill rolls has been greatly increased to permit a freer flow of the expressed juice, but the improvements have been mainly in the accessories, particularly in the preparation of the cane for the mill and the handling of the juices for maceration purposes. Shredders and crushers for breaking up the cane were introduced many years ago, the crushers consisting of two (rarely three) deeply grooved rollers, which break the cane and express a part of the juice, while shredders are rapidly revolving toothed wheels which act as the name implies, but do not extract any juice. Most of the mills are equipped with crushers, and when shredders are employed these usually are auxiliary to the crushers.

Revolving knives have recently been added for preliminary preparation of the cane entering the crushers and are now quite general. The knives consist of a set of blades on a rapidly rotating shaft located about one-third of the way up the cane carrier. The purpose is to cut the cane into short pieces or chips and also to level the mat so that there is a more even feed to the crushers, with corresponding increase in capacity or extraction of juice, or both, for a given grinding equipment.

The latest innovation is the Morgan cane disintegrator, which takes the place of the crusher. In effect the disintegrator is a large centrifugal pump with a solid steel impeller revolving at a speed of 600 r.p.m. The vanes on this impeller correspond to similar vanes in the casing, the clearance being small. The cane, cut into chips by knives, passes into the casing and is torn into a fluffy mass by the impact between the revolving and stationary vanes, after which it goes through the regular grinding process. No juice is extracted by the disintegrator.

From the earliest days of multiple mills, water has been sprayed on the partly extracted bagasse before it enters the last set of rolls. This saturation, or maceration, was later extended to double maceration, in which the

Presented on Dec. 10, 1930, at the New Orleans meeting of the American Institute of Chemical Engineers.

Few, if any, industries are more dependent upon chemical engineering than is the production of sugar. With a highly developed and specialized technology entirely dependent on chemical control it employs a majority of the unit operations of chemical engineering

INDUSTRY

World's Largest Cane-Sugar Mill With a Record of 1,046,000 Bags of 325 Lb. Each in a Single Season, Central Delicias, Cuba

thin juice from the last mills is returned to the bagasse entering the next to the last set of rolls, the water being added on the last set as before. With the increase in the number of sets of mills the natural consequence was compound maceration, in which the juices from two or more sets of mills were returned separately to the carriers of preceding mills. This method was recognized as the correct and logical procedure, but the multiplication of juice strainers, juice tanks, pumps, and piping under the mills became a real danger in sugar losses. This has been entirely overcome by the introduction of strainerless juice pumps, which take the juices as they come from the mills, trash and all, and return them to the preceding mills. The pumps used are of the type designed for sewerage and dredging work.

The matter of cleanliness around the mills has received special attention lately because of the recognition of sugar losses through fermentation in the troughs, tanks, and strainers under the mills. Bacteriologists have shown that a handful of sour bagasse or cane trash can infect the whole stream of warm juice flowing over it. Bagasse conveyors or carriers between the mills have been introduced which have fewer parts than the older type slat conveyor; screens for straining the juice before sending it to the process have been made more accessible for cleaning; and new designs of strainers are being employed which may be placed above the mills. There is no doubt that incalculable savings have been effected by this increased cleanliness.

In former years the bagasse, or cane residue from the mills, was the regular fuel of the factory, but in Louisiana and a few other districts, this practice has been almost entirely discontinued, and it is now sold as a raw material to manufacturers of building and insulating board. The cellulose has also been found to have certain specialized values, as in the making of explosives and rayon.

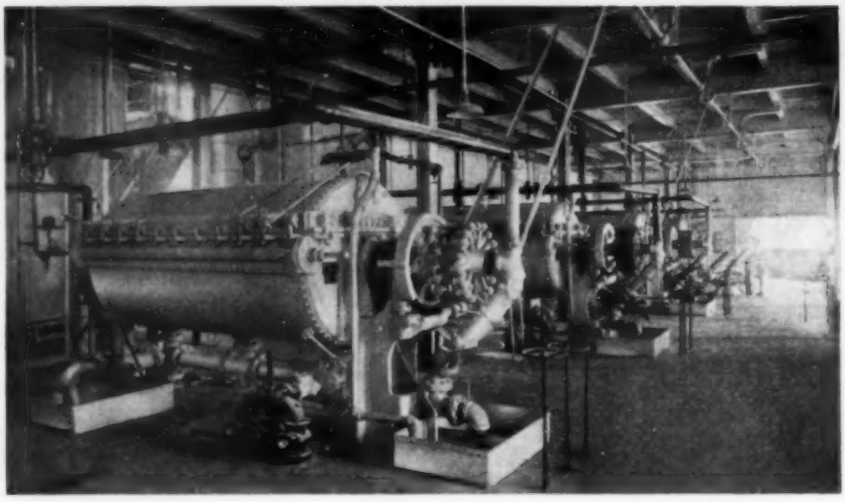
The Vascane process for the simultaneous manufacture of sugar and fiber board from the cane is in the experimental stage. The cane is disintegrated by shredding it against an abrasive wheel, after which it is put through a regular counter-current diffusion process, the extraction being better than 99 per cent, leaving the cane fiber so pure that it goes direct to the manufacture of the fiber board. The juice for processing has a dilution of about 30 per cent, the same as that obtained by the regular milling process. Here is a return to diffusion—abandoned in the cane industry some 35 years ago because of the high cost of excess fuel—now made practicable because of a more valuable use for the bagasse.

The juice in practically all raw sugar manufacture is clarified by lime and heat, followed by sedimentation and decantation. In a few instances the precipitate is increased by adding sulphur or a soluble phosphate before the lime. There has been no change in the basic process (though Java is now experimenting with pressure filtration of the cold juice as a preliminary treatment), but the technology and apparatus of clarification have altered profoundly in recent years.

Aiding in the changes have been two contributions of pure science: the use of pH control and the application of colloid chemistry. Not only have colorimetric pH tests become general in determining the correct quantity of lime to be added but electrometric recording instruments also are in use. In a few factories the addition of the lime is actually carried out by electrical methods actuated by pH recorders. Extensive investigations have been made by the carbohydrate division of the Bureau

of Chemistry, as well as by others, on the subject of colloid elimination in clarification, and most of this work has been made possible by the accurate adjustment of reactions by pH measurement. A further refinement of clarification is promised by the continuous determination of dissolved lime salts by conductivity methods.

The use of the Dorr clarifier is a development of the last ten years. Continuous settling equipment was in use many years ago, but was largely abandoned in favor of the simpler open defecator and intermittent decantation. The Dorr clarifier has all the advantages of continuous clarification (fuel economy, less mud draw-off, less juice in process, clearer juice on the average) without the disadvantages of the older continuous types, where fermentation was common, mud draw-off was heavy and intermittent, and cloudy juice was a frequent fault.



Pressure Filters in Suchar Process Refinery in Porto Rico

The Dorr clarifier is used with the regular defecation and also as an adjunct of the Petree-Dorr system, which is a radical departure from the older methods. The principal element of the process is that the mud waters, instead of being sent to filter presses, are sent back to the mills and sprayed on the bagasse for maceration purposes. The juice is filtered out by the blanket of bagasse and returns to the process, while the mud goes to the boilers. A double defecation also is a feature of the Petree-Dorr process; the mud from the primary settler is mixed with the second mill juice and is passed through secondary heaters and secondary settlers. The mud waters from this secondary settling are sent back to the bagasse carrier between the second and third mills while the secondary clear juices go through the primary settling system. The great advantage of the process is that the filter-press station is entirely eliminated. An objection is that the ordinary method of chemical control (weighing the cold juice as it comes from the mills) becomes impracticable, and the methods which must be substituted are less positive.

Except where it is completely eliminated by the Petree-Dorr system the filter-press station for mud waters remains much as it always has, with plate-and-frame presses in general use. Continuous suction filters of the vacuum type are being experimented with in a few houses and may gain favor.

Pressure filtration, with inert filter aids, of the clarified juice and of the evaporated syrup after it leaves the multiple effects has been tried and results in greatly improved sugars, but except in the manufacture of "plantation granulated" or "direct consumption" sugars, the extra cost is prohibitive.

Multiple-effect evaporation was developed in Louisiana about 100 years ago by Rillieux. Many different types of evaporators have been patented and tried out, but practically all the cane factories use the so-called "standard" effect with vertical tube calandria, generally in quadruple effect. Recent modifications in evaporators look toward steam economy, and include "robbing" the first body of the effect of vapor for use in juice heating. An extension of this idea is the addition of a vapor cell ahead of the first body of the effect, the juice being heated with exhaust steam while all the vapor from this cell goes for juice heating. A further extension of the vapor cell is the dead-end double effect ahead of an evaporator.

Pauly-Greiner pre-evaporators have been used extensively in beet-house evaporation, and have found some use in cane factories where electrification and other steam economies have reduced exhaust steam below the boiling-house needs. Live steam at about 40 lb. is used in the calandria, and the vapors from the juice go to the exhaust steam system of the factory. The Pauly acts somewhat as a reducing valve.

Boiling to crystallization is done in single-effect vacuum pans, the calandria type having superseded the coil pan almost entirely in raw-sugar-house work. The technology of pan boiling has progressively altered, beginning with the manufacture of one grade of sugar only, and the gradual abolition of the old-style hot room. Crystallization in motion was substituted and low-grade sugars have disappeared from the market. Pan-boiling systems have been steadily improved with a view to greater exhaustion of residual molasses, less in-boiling of impurities, fuel economy, and the improvement of the final product.

Within the last few years crystallizers have been equipped with cooling coils for the more rapid working of low-grade products. In the simplest form, the Kopke coils, are banks of tubes placed between the rotating arms of the crystallizer through which cold water is circulated until the desired temperature is reached (about 95-100 deg. F.). Just before sending the cooled massecuites to the centrifugals, hot water is circulated through the coils until the mass is about 125 deg. F. This warming facilitates centrifuging by reducing the viscosity of the molasses, and gives a cleaner sugar. A crystallizer equipped with cooling coils has about 70 per cent greater capacity than one without.

A still more elaborate cooler-crystallizer is the La Feuille rotary crystallizer, which is not only equipped with coils but also rotates slowly on trunnions to insure greater circulation. The expense of this apparatus has militated against its adoption, but there is no doubt that it is highly efficient.

A process patented by Hershey consists of discharging the syrup at heavy density from the vacuum pan and gradually cooling it in long trough conveyors until it forms a pasty mass of fine crystals holding all the ingredients of the cane juice. An extensive market for this "whole sugar" has not yet developed.

Centrifugals are the means par excellence for the separation of crystals and mother-syrup. The self-discharging centrifugal is in great favor in the raw sugar factory, this type having a bottomless basket. It is charged while running and the massecuite is delivered on a ring on the spindle so that it is thrown against the outer wall and purged of its molasses, and when the machine is stopped the sugar drops of its own accord through the bottom of the basket. The capacity is about double that of the old-style machine.

Considerable attention is now paid to the centrifuging of the crude grades as it has been proved beyond question that their deterioration while in storage is entirely preventable by a proper control of the moisture content. The relationship between moisture and polarization must be such that the moisture divided by 100 minus polarization is less than 0.25. General adherence to this safety factor has largely eliminated a loss that formerly ran to hundreds of thousands of dollars annually. Other factors, such as proper clarification of the juice, size and shape of grain, indirectly affect the storing qualities of raw sugars by making it easier to attain the proper safety factor. Gross contamination by yeasts, molds, and bacteria also is to be avoided, and dry storage conditions are essential to prevent sweating of bags and absorption of moisture beyond proper safety limits.

Advances in the refining field during the past decade have been greatly aided by a more liberal policy on the part of refinery technologists in the matter of publications as well as by a freer interchange of ideas between the refineries themselves. The mistaken policy of secrecy in vogue formerly was a factor in preventing advancement along broad lines in this branch of the industry.

Possibly no phase of sugar work has received so much scientific attention in recent years as the refining quality of raw sugars. Instigated largely by the refiners in an attempt to get better sugars, investigations have been taken up by government chemists and by raw sugar manufacturers with a view to improving the working qualities of their product. The result has been that the grain size and conformation, color constituents, colloid content, pH, character of the ash, and filtrability of raw sugars are now investigated, whereas a dozen years ago the polarization was the only point of general interest. The raw manufacturing process, particularly the clarification and the pan-boiling systems, is directed toward this idea of producing a product satisfactory to the refiner in these numerous respects. Storage qualities and the moisture content, already referred to, also are of deep interest to both buyer and seller.

The first step in the refining process consists of removing the film of molasses from the raw crystal by mingling with a heavy syrup and centrifuging. Self-discharging machines are used almost universally for wash-plant work and they generally are fitted with automatic water sprays and automatic timing and stopping devices.

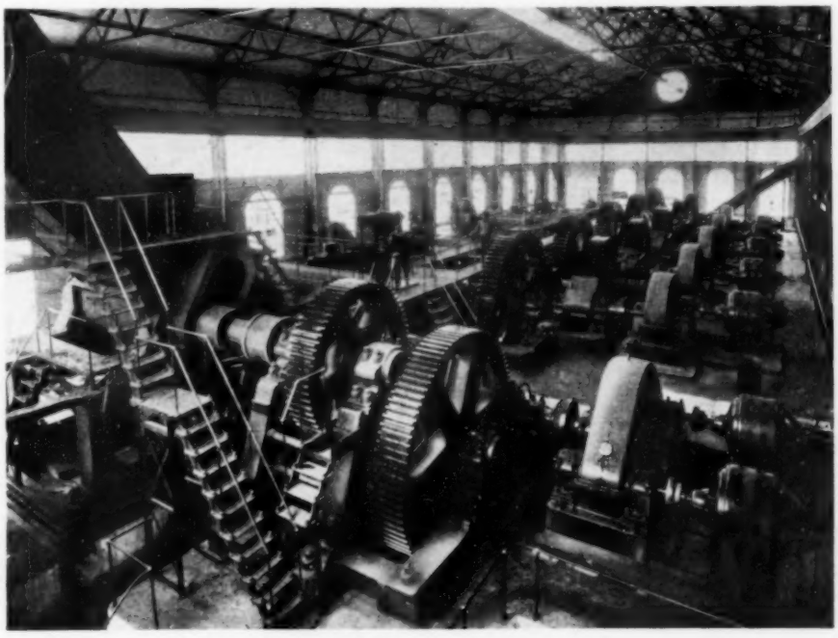
The defecation and cloth filtration station has seen the most radical change in the refining process, and there is still great divergence in practice between different refineries. The introduction of pressure filters of the leaf type (Kelly and Sweetland) brought into prominence the use of the inert filter-aid kieselguhr (generally called by the trade name Filter-Cel) for defecation, which had been advocated many years before as an aid to bag filtration and mud-press work. Following the Sweetland came the Vallez rotary filter press, in which it was possible to use paper pulp as the inert material. Filter-Cel was put on the market in several grades of different filtration rates and it was found possible to use ordinary plate-and-frame presses with Hyflo Filter-Cel for filtering both washed sugar liquor and raw sugar washings.

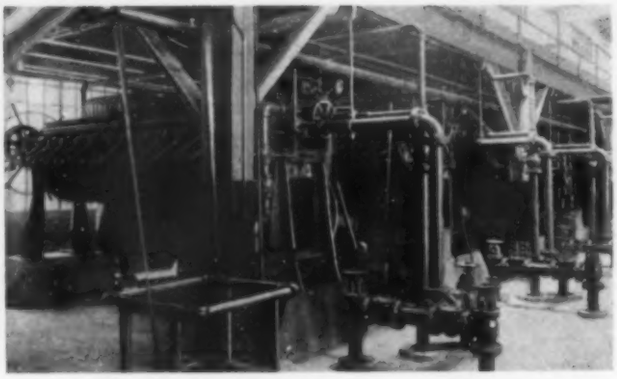
About 12 years ago the Williamson clarification system was patented. This does not depend on any filtration at all, but is in effect an air-flotation system. The washed sugar liquor at about 160 deg. F. is treated with phosphoric acid and lime, then impregnated with air, and allowed to flow into tanks having steam tubes in the bottom. As the air-charged liquor flows continuously over this heating surface the temperature is raised to 210 deg. F. and the air-bubbles rise, carrying the parts of precipitate with them. A heavy blanket of scum is thus formed which is pulled over a lip at the end of the tank by a slowly moving roller, after which it is diluted and filtered through plate-and-frame presses.

Further complications are added by the use in the same refinery of one of these systems on washed sugar liquor and another on raw washings, while the addition of a small quantity of phosphoric acid with the inert filter aid is the practice in certain refineries. Hardly any two plants follow identically the same defecation technique or use identical apparatus at the filter station. Those plants which use paper pulp recover it by regular countercurrent pulp-washing systems. Many of the larger refineries using kieselguhr send the press cake to large furnaces where the organic matter is burned away and the filter aid recovered so that it can be re-used.

Outwardly there has been little change in the boneblack filtration process. Percolation through char in cistern-like filters and revivification in vertical pipe-retort kilns continues as

Electrically Driven Fifteen-Roller Cane Mill With Double Crusher





Filtering Syrups Through a Low-Pressure Unit (Sweetland Pressure Filters) in a Southern Refinery

it has for many years. But there has been a great deal more learned about boneblack and its action on sugar liquors in the past ten years.

Several factors have been instrumental in this advance in the chemistry and technology of char filtration. The freer publication of investigations by refinery men is one important agency; investigation by outsiders on the comparative values of boneblack and decolorizing carbons is another. The application of colloid chemistry and the recognition that boneblack acts by adsorption according to Freundlich's equation have been points of these investigations. Two advances in analytical procedure have made most of these investigations possible. Hydrogen-ion determinations on both the liquors and the boneblack itself opened up a new field of research besides being of inestimable value as an aid in the routine control of the char house in actual practice. The second analytical contribution was the introduction of spectro-photometric methods of color analysis, largely through investigations made at the Bureau of Standards.

A distinct advance in handling char filters is the practice of "wet-filling," which consists in adding the char and liquor simultaneously to the filter instead of char first and liquor afterwards as in the older method. The device most generally used is a set of staggered funnels hung in the top of the filter by which the char and liquor are intimately mixed. Besides the time saved by the simultaneous operations, channeling is almost entirely eliminated and washing the filter with hot water is greatly facilitated by wet-filling.

While generally referred to as separate processes, the use of activated carbons in powdered form is essentially the regular refining process with the carbon substituted for boneblack. There is a vast difference in the actual practice, naturally, since the carbons are used in relatively small proportions and are added to the liquor and then filtered out by filter-pressing after decolorization has taken place. The Suchar process is the one in most general use on this side of the water.

The activated carbons have so far been used only as an adjunct of a raw-sugar factory for refining purposes in the tropics, but they have not replaced the use of boneblack in any standard refinery in this section.

Such apparatus as multiple-effect evaporators, vacuum pans, crystallizers, and centrifugals, which are common to both raw sugar manufacture and refining, follow much the same changes in both branches. Evaporators play a minor part in the refinery, and robbing the effects of steam is not general practice. The calandria pan is used for remelts and low-grade sugars and is quite successfully employed also for white sugar in some few refineries. Crystallizers also are less prominent in the refining branch, but the cooler coils and cooler crystallizers already described have come into the same use as in the crude-sugar house.

In one refinery continuous vacuum filters of the Oliver type have proved practicable for the separation of crystals and syrup in place of the centrifugal machine. Whether or not this type of filter will actually replace the centrifugal to any extent will be determined in the next few years.

Granulators for drying the crystals after centrifuging are rotary dryers, filled with saw-toothed flights for distributing the sugar evenly through the air current, which is first heated and then drawn through the length of the granulator drum. Considerable advance has been made in the dust-collecting systems used in conjunction with these dryers; the general form is the cyclone type, where the dust-carrying vapors are caused to whirl, dropping the dust out by centrifugal force. Another more recent form is the Vorticose dust collector, in which the dust is caught by a series of staggered vertical baffles. The fine crystals caught by both the cyclone and Vorticose systems are sold as fruit or cereal sugar.

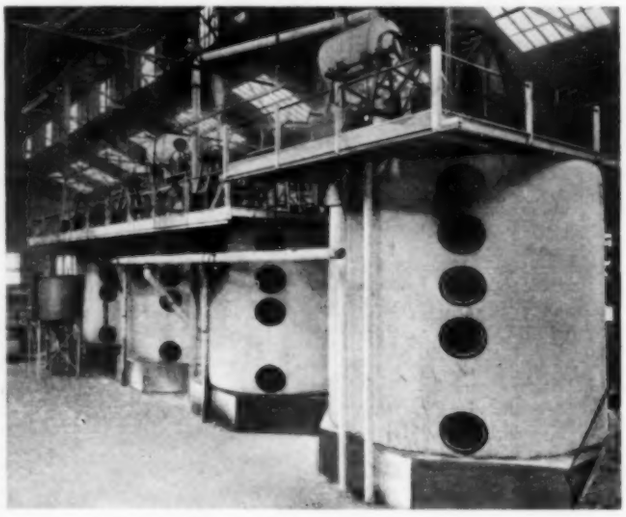
The Wayne-Varnau process takes the high-test, heavy syrups from the white-sugar-centrifugal machines and obtains a second set of crystals by a carefully graduated cooling in thermostatically controlled crystallizers of special design. The chilled mass is purged cold and yields a fine, even sugar of soft texture which is said not to cake on storage.

Screening of refined sugar has undergone a complete change. The reel bolter has been almost entirely superseded by the shaking or vibrating inclined types of screens. The Hummer screen is vibrated electrically, while in the Newaygo type the screen is tapped mechanically to obtain the vibration. Horizontal screens such as the Rotex are used for the screening of finer sugars and pulverized grades.

Pulverizing mills are of different types, most of which have been in use many years. A recent device, the Mikro pulverizer, claims a finer product and greater capacity without the use of screens.

Packaging has become an important part of the refining branch, as in all food industries, and automatic machinery is now used almost entirely in filling cartons, bags, and boxes.

Installation of Dorr Clarifiers in a Hawaiian Cane Sugar Mill



Low-Cost Hydrogen Produced By Ammonia Dissociation

By J. F. T. BERLINER and G. W. BURKE

National Ammonia Company
Philadelphia, Pa.

ECONOMIC PRODUCTION, distribution, and handling of gases, particularly hydrogen, are factors of primary importance in numerous industrial processes. In the case of hydrogen, these have not kept pace with its rapidly multiplying applications. With the exception of the very large scale production of hydrogen, as in the manufacture of synthetic ammonia or the hydrogenation of petroleum and coal, there has been no significant advance in methods of manufacture or distribution nor any reduction in cost for this gas over a period of several years.

Rapid development of the synthetic ammonia industry has placed anhydrous ammonia among the cheapest and purest of the heavy chemicals. The possibilities of utilizing ammonia as a source of hydrogen have been studied and found to be both highly practical and economical. Anhydrous ammonia is low in cost, easy to transport, practically free of all impurities, easily handled and stored, and is readily available throughout the country through the maintenance of a large number of amply supplied stock points.

It has long been known that anhydrous ammonia may be dissociated or "cracked" directly into its component elements through the reversal of the conditions required for its synthesis:

$$2\,NH_3 \rightleftarrows N_2 + 3\,H_2$$

Subjecting ammonia to low pressures and high temperatures will result in its decomposition. Relatively low temperatures may, however, be employed in the presence of a suitable catalyst, which will also result in very much higher rates of dissociation. The apparatus developed by the DuPont Ammonia Corporation for effecting the dissociation is described in some detail in the latter portion of this paper.

By passing ammonia vapor over a catalyst heated to about 600 deg. C., at pressures ranging from below atmospheric to about 15 atmospheres or higher, the vapor is practically completely decomposed to nitrogen and hydrogen. The product of the dissociation consists of a mixture of 75 per cent by volume of hydrogen and 25 per cent by volume of nitrogen, or 17.76 per cent by weight of hydrogen and 82.24 per cent by weight of nitrogen.

Application—In almost all instances where hydrogen has been employed, or proposed for use, the presence of nitrogen is not detrimental. The dissociated, or "cracked," ammonia should directly replace hydrogen in all but a few of its numerous applications.

In copper and brass brazing, in the bright and black annealing of iron, in the bright annealing of copper, in atomic-hydrogen arc welding, in shielded-arc welding, in annealing of nickel-plated iron and steel, in the maintenance of reducing atmospheres in furnaces and in chemical processes, and in a number of other uses, the presence of the nitrogen in the hydrogen is of a distinct advantage and highly desirable.

Among other uses wherein dissociated ammonia may be directly substituted for hydrogen are the reduction of metallic oxides, annealing and swaging of such metals as tungsten, molybdenum, and tantalum, the melting and working of platinum, the decarburization of steel and cast iron, removal of sulphur from coke, the cooling of electric generators and transformers, in lead burning, in aluminum soldering, brazing and welding, in reduction of organic compounds by direct or catalytic means, in the oxy-hydrogen torch, and in the melting and working of silica or fused quartz. Dissociated ammonia may also find some applications in the hydrogenation of edible fats and oils and in the filling of balloons and airships.

Due to the relatively low heat capacity of nitrogen, the flame temperature of the oxy-"cracked ammonia" combustion is not very much lower than that of the oxy-hydrogen flame. Exact measurements of the flame temperature have not yet been completed, but it appears to be of the order of 150-200 deg. lower than that of the oxy-hydrogen flame under the same conditions.

Economics—If a material be technically suitable, to be industrially acceptable it must be readily available and low in cost. As to the availability of ammonia nothing need be said. Consideration of the economic features of the dissociation of ammonia leads to the conclusion that cracked ammonia is one of the most economical methods for the small-scale production of hydrogen.

If 1 lb. of anhydrous ammonia be vaporized at atmospheric pressure and room temperature (70 deg. F.), it occupies 22.7 cu.ft. On dissociation this yields 45.4 cu.ft. of gas containing 34 cu.ft. of hydrogen and 11.4 cu.ft. of nitrogen.

A standard ammonia cylinder contains 100 lb. of anhydrous ammonia which on dissociation will yield 4,540 cu.ft. of dissociated ammonia, containing 3,400 cu.ft. of hydrogen. (Ammonia is shipped also in cylinders containing 150 lb.) A standard hydrogen cylinder is rated at a capacity of 200 cu.ft. of gas. It may be seen that in instances where the presence of nitrogen is actually advantageous, one cylinder of ammonia is equivalent to about 22 cylinders of hydrogen, while on the basis of the hydrogen content alone, it is equivalent to 17 cylinders of hydrogen.

It may at first appear paradoxical that low-cost hydrogen can be obtained through the circuitous route of synthesizing ammonia from manufactured hydrogen, and subsequently dissociating this ammonia to obtain the hydrogen. It was previously noted that for large demands this method of obtaining hydrogen is not economic. However, this is not the case for relatively

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smaller hydrogen requirements. The cost of hydrogen manufactured for use in the large-scale production of synthetic ammonia is extremely low compared to the cost of commercial hydrogen supplied in cylinders. Ammonia is transported as a liquid which contains a high concentration of available hydrogen. This means of veritably transporting liquefied or "stored" hydrogen presents a system for producing hydrogen at a material reduction in cost compared to the present cost of commercial hydrogen. This is manifested in the savings effected in overhead charges on cylinders, elimination of high compression charges, material reduction of shipping, handling, and storage charges; reduction of purchasing and distribution costs, etc.

Present average domestic prices of liquid anhydrous ammonia in standard-size tank cars and cylinders are estimated at 6 cents and 16 cents per pound, respectively. Thus the cost of the ammonia for producing 1 M cu.ft. of dissociated ammonia is $1.32 and $3.52, respectively, on the basis of the above tank-car and cylinder

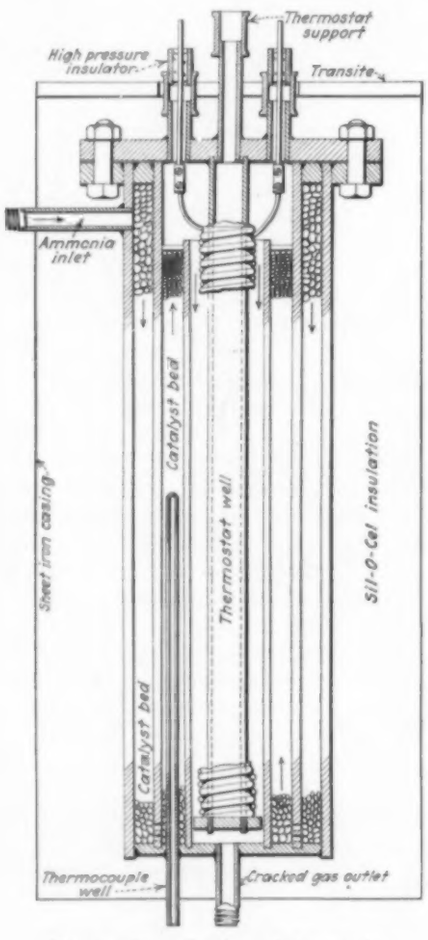


Fig. 1—Cross-Section of Ammonia Dissociator

prices. Similarly, the corresponding costs of the equivalent quantity of hydrogen present in the gas are $1.76 and $4.70 per M. cu.ft.

The dissociator or ammonia cracker is neither difficult nor expensive to construct. The design herein described employs standard stock materials. It may be said at this point that there is very little difference in the cost of building the crackers for various capacities from 50 to 1,000 cu.ft. of dissociated gas per hour, since they differ only in length, size of electric heater unit, and amount of catalyst charge. The cost of operation of the dissociators is very low. A liberal estimate of all charges upon the equipment and its operation is about 1 cent per pound of ammonia dissociated. This item contributes an additional cost of 22 cents per M cu.ft. of dissociated ammonia and 30 cents per M cu.ft. of the hydrogen contained therein. The total costs therefore for dissociated ammonia are $1.54 and $3.74 per M cu.ft. and for the hydrogen present, $2.06 and $5 per M cu.ft. at tank-car and cylinder costs of ammonia, respectively.

The present average cost of commercial hydrogen in cylinders is conservatively estimated at $10 per M cu.ft. (200 cu.ft. per cylinder at $2 per cylinder). In other words, the use of ammonia from cylinders as a source of hydrogen results in a net saving of 50 per cent as compared to the cost of commercial hydrogen obtained in cylinders. If tank-car quantities of ammonia be employed, an 80 per cent saving is realized. To this saving should be added the economies incident to materially lowered handling and labor charges.

Nitrogen—It may be pertinent to mention at this point that dissociated ammonia may be utilized also as a means of obtaining very low-cost nitrogen. If dissociated ammonia be burned in a closed combustion chamber with the correct quantity of air, the products of combustion will be nitrogen and water:

$$\overbrace{6\,H_2 + 2\,N_2}^{\text{Cracked Ammonia}} + \overbrace{3\,O_2 + 12\,N_2}^{\text{Air (Approx.)}} = 6\,H_2O + 14\,N_2$$

The burning of 8 volumes of dissociated ammonia with nearly 15 volumes of air will result in approximately 14 volumes of nitrogen. Or, in other words, 100 lb. of ammonia will, on dissociation and subsequent burning with air, yield somewhat over 7,800 cu.ft. of nitrogen. The contents of one cylinder of ammonia on conversion to nitrogen yields a volume of this gas equivalent to that ordinarily contained in 39 standard cylinders (200 cu.ft. each) of nitrogen.

Cost of the nitrogen, allowing for cost of dissociation and burning (estimated total over-all at 1.5 cents per pound of ammonia), is $2.24 per M cu.ft., based on the price of ammonia in cylinders (96 cents per M cu.ft. employing tank-car prices).

The present average cost of a cylinder of nitrogen (200 cu.ft.) is about $2.20, or equivalent to $11 per M cu.ft. The use of nitrogen derived from ammonia by the above system will result in an 80 per cent reduction in the present cost of nitrogen, based on the present cylinder ammonia price (or about 90 per cent on tank-car price). The economies which will result from the 97.4 per cent reduction of cylinder handling charges through the substitution of one cylinder for 39 is also an important factor to be considered.

Ammonia-Cracking Equipment—The apparatus for dissociating ammonia consists of a dissociator, a vaporizer, and the control equipment. The dissociator consists essentially of three pieces of standard pipe welded to heads to form two concentric annular spaces and a well in the center for a heater. A cross-section of the arrangement is shown by Fig. 1. The outside annular space is completely filled with catalyst. The inner annular space also is filled with catalyst which is held in place by a perforated ring at the top. A thermocouple well occupies a position in the center of the inner catalyst chamber.

In order that access may be gained to the heater and

inside catalyst chamber, the head is removable. It is held in place by eight bolts. A gasket of sheet asbestos $\frac{1}{32}$ in. in thickness is used to make a gas-tight joint between the machined faces of the head and dissociator body. Three pieces of seamless tubing are welded into the top of the head. One of these serves as passage and support for a thermostat, and the other two serve as connections for gas-tight, glass-insulated electrodes that conduct the current to the heater. They consist of Dumet wire insulated from seamless steel tubing by means of Pyrex glass. They occupy an elevated position, so that the glass will not be softened by the heat of the dissociator. A 1-in. pipe is welded to the center of the head on the lower face. This serves as a support for the heater and also as a thermostat well.

The heater consists of a standard alundum electric furnace core wound with Nichrome IV resistance wire. Porcelain insulators and connecting couplings are used. To minimize radiation losses, the dissociator is surrounded by about 3 in. of an insulating material such as Sil-O-Cel, contained in a sheet-iron casing. The top is closed by a circular Transite board.

Three dissociators have been designed with rated capacities of 50, 250, and 600 cu.ft. of dissociated ammonia per hour. When operating at full capacity, these crackers will deliver 150, 600, and 1,000 cu.ft. of dissociated ammonia per hour. They differ only in their length and in the amount of electric energy consumed. In length, they are approximately 15, 27, and 33 in. The electrical inputs are approximately 2.5, 8, and 15 kw. when operating at full capacity.

Gaseous ammonia may be partially dissociated as it passes over iron heated to 500 deg. C., or higher. The amount and rate of dissociation is somewhat dependent on the temperature. Within reasonable working ranges, such a method could not be economically and efficiently employed. Further, steel at elevated temperatures is quite severely nitrided as the ammonia dissociates on its surface. To overcome these difficulties, a catalytic agent is employed. In connection with this apparatus the catalyst plays two parts; it serves first as a medium of heat transfer which assists in rapidly heating the incoming ammonia to the dissociation temperature, due to the relatively great surface it presents; and second, as a material that stimulates and accelerates the dissociation of the hot ammonia into its constituent gases, hydrogen and nitrogen. Further, it acts as a reagent to bring about conditions that materially decrease the formation of iron nitride on the heated inner surfaces of the dissociator, which are exposed to the undissociated ammonia.

Ammonia gas enters the apparatus through the intake pipe welded to the top of the outside shell. The gas passes down through the outside charge of catalyst, up through the inner bed of catalyst, and finally down over the heater and out through the discharge pipe at the bottom.

It has been demonstrated that incandescent Nichrome wire serves as an excellent medium for cracking ammonia. During this work, it was observed that the Nichrome wire was quite severely attacked as ammonia was dissociated upon its surface. It was further observed that the attack was materially diminished when the ammonia was diluted with dissociated ammonia. For these reasons the dissociator is designed so that the ammonia is completely dissociated before it comes in contact with the heater. Also, as steel is nitrided when exposed to ammonia at high temperatures, the apparatus

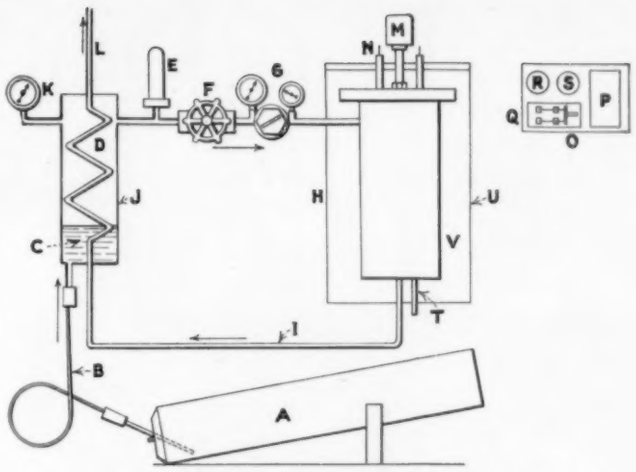


Fig. 2—Diagrammatic Arrangement of Dissociator and Associated Equipment

A, Ammonia cylinder; *B*, Flexible connection tube; *C*, Liquid ammonia; *D*, Gaseous ammonia; *E*, Safety valve; *F*, Control valve; *G*, Reducing valve; *H*, Dissociator; *I*, Cracked ammonia discharge line; *J*, Vaporizer; *K*, Pressure gage; *L*, Cooled cracked ammonia; *M*, Thermostat; *N*, Heater terminals; *O*, Control board; *P*, Contactor; *Q*, Switch; *R*, Ammeter; *S*, Millivoltmeter; *T*, Thermocouple well; *U*, Casing; *V*, Heat insulation.

is designed so that all the metallic surfaces at a temperature of 450 deg. C., or more, would be exposed to wholly or partially dissociated ammonia.

With the heater extending through the center of the apparatus, heat transfer is effected by radiation and conduction. Heat is first absorbed by the inner catalyst bed, and from there transferred by conduction through the outside catalyst bed to the shell, where it comes in contact with surrounding insulation. By such an arrangement, it is apparent that the greatest thermal efficiency will be realized. As the heat energy travels from the heater outward, it performs the two essential operations of the process: namely, that of heating the ammonia to the dissociation temperature and of supplying the heat for the endothermic reaction of dissociation. The heat lost is that escaping by conduction through the insulation and the sensible heat of the exit gas. The latter is recovered to effect vaporization and moderate preheating of the ammonia before it enters the dissociator.

The Vaporizer—When ammonia is withdrawn from a cylinder as a vapor at a rate in excess of about 1.5 to 2 lb. (34 to 45 cu.ft.) per hour, there is not sufficient heat transfer through the cylinder walls to supply the required heat of vaporization to the liquid ammonia. This produces a refrigerating effect within the cylinder, and results in a drop of pressure and diminished flow. To avoid this difficulty, a vaporizer is employed. The liquid ammonia is withdrawn from the cylinder or storage and conducted to the vaporizer, in which it is converted into a vapor.

This vaporizer consists of a steel pipe, 6 in. in diameter, with heads carrying pipes for admitting liquid ammonia and removing vaporized ammonia, welded to the ends. A coil of $\frac{1}{4}$- or $\frac{3}{8}$-in. seamless steel pipe is placed inside the vaporizer, and through this the hot dissociated ammonia from the cracker is conducted. By this system, the sensible heat of the gases flowing from the dissociator is recovered and employed to vaporize, and under proper conditions, partly to preheat, the incoming ammonia.

To illustrate this the data of Table I are given, presenting the operation of a vaporizer employed with a dissociator which has a capacity of 150 cu.ft. of disso-

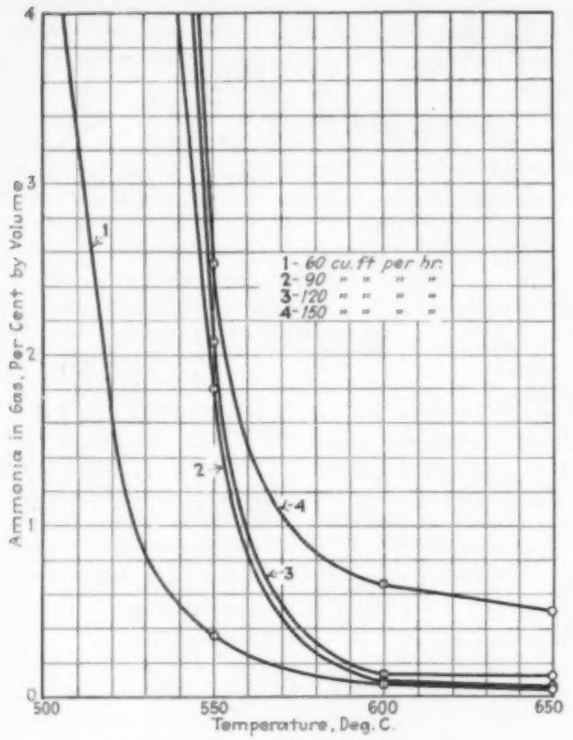


Fig. 3—Relations Between Operating Temperature, Capacity, and Undissociated Ammonia in Ammonia Cracking

ciated ammonia per hour. This table makes evident the characteristics of the vaporizer at different rates of operation of the dissociator.

From these data it will be observed that the vaporizer had sufficient capacity to supply the dissociator with ammonia gas, regardless of the rate at which the dissociator was operated. At low outputs, sufficient heat was available to vaporize the ammonia, but no preheating was accomplished. Higher rates of flow gave better heat transfer, resulting in partly preheating the ammonia. The higher rates of flow are conducive to more uniform, efficient, and economical operation.

Control Apparatus—Temperature control is effected by means of a quartz-rod-type thermostat that operates a relay or contactor. The thermostat, being adjustable, allows the maintenance of any desired temperature. In order that the temperature may be known and the thermostat more accurately adjusted, a small inexpensive millivoltmeter, attached to a base metal thermocouple in the dissociator, should be employed.

Experimental data summarized in Fig. 3 indicate that the dissociator should be operated so that the hottest

Table I—Vaporizer Operating Characteristics

	—60 Cu.Ft. per Hour— Temp., Deg. C.				120 Cu.Ft. per Hour Temp., Deg. C.				150 Cu.Ft. per Hour Temp., Deg. C.			
Time, Minutes	NH_3 Pressure	Exit Gas	Vaporized NH_3	Shell	NH_3 Pressure	Exit Gas	Vaporized NH_3	Shell	NH_3 Pressure	Exit Gas	Vaporized NH_3	Shell
0	125	28	28	27	150	27	27	26	150	51	52	47
10	130	27	28	25	170	29	29	29	150	52	53	46
20	140	26	27	25	185	31	32	32	150	56	58	50
30	140	26	26	25	145	33	34	33	150	60	62	54
40	145	26	26	26	150	39	40	38	150	64	65	57
50	145	26	26	26	150	44	45	41	150	65	66	57
60	145	26	27	26	150	46	47	43	150	66	67	58
70	...	..	..	..	150	49	50	45	150	67	68	59
80	...	..	..	..	150	51	53	47	150	68	69	60
90	...	..	..	..	150	53	53	48	150	68	69	60
100	...	..	..	..	150	53	54	48	150	68	69	60
120	...	..	..	..	150	53	54	48	150	..	..	..

point of the catalyst bed is between 500 and 600 deg. C. Within this range the dissociation of ammonia is most complete.

Flow of ammonia is controlled by means of a steel needle valve placed between the vaporizer and the dissociator. The vaporized ammonia then flows through a standard-type automatic reducing valve, which maintains a constant pressure and, therefore, a constant flow of vapor through the dissociator.

It is desirable to have a pressure gage and safety valve attached to the vaporizer. A flexible, high-pressure tube is the most suitable means of conducting the liquid ammonia to the vaporizer.

In Fig. 2 the apparatus is shown completely assembled. This comprises the dissociator; a vaporizer to convert liquid into gaseous ammonia; a thermostat by means of which a constant temperature is maintained; and a reducing valve that automatically maintains the ammonia flow so as to deliver the dissociated ammonia at constant pressure. The apparatus is entirely automatic in its operation and requires little or no attention.

Before the apparatus is put into operation initially, it is necessary to activate the catalyst. This is accomplished by reduction, in place, with either hydrogen or ammonia. Ammonia is more convenient and just as efficient for this purpose as hydrogen.

In order to determine the optimum operating conditions, the dissociation of ammonia over a catalyst was studied at various space velocities and at various temperatures. The results obtained may best be illustrated by the data obtained on a cracker having a maximum capacity of about 150 cu.ft. per hour. The observations on this cracker are presented in Table II.

Table II—Operating Characteristics of an Experimental Dissociator

Run No.	Temp. of Inlet Catalyst, Deg. C.	$3H_2 + N_2$ Cu.Ft. per Hr. of Cracked Gases at 0 Deg. C., 760 Mm.	Ammonia in Exit Gas, Per Cent by Volume	Dissociation at Bottom of Outside Catalyst Chamber, Per Cent by Volume	Temp. of Exit Gas, Deg. C.	Temperature on Outside Shell of Dissociator: Top, Deg. C.	Middle, Deg. C.	Bottom, Deg. C.	Dissociation, Per Cent by Volume
1	635	65.6	0.049	95	475	385	525	460	99.95
2	635	89.0	0.058	90	515	375	520	450	99.94
3	635	113.5	0.124	80	560	360	490	435	99.98
4	650	165.0	0.503	65	465	360	480	420	99.50
5	590	54.2	0.075	90	412	365	485	440	99.93
6	600	79.2	0.090	85	455	360	480	430	99.91
7	600	107.8	0.120	70	485	340	445	415	99.98
8	600	160.5	0.655	60	530	335	445	405	99.34
9	550	60.0	0.361	90	380	370	460	430	99.64
10	545	91.2	1.81	70	455	345	440	405	98.19
11	550	109.6	2.08	60	475	335	435	400	97.92
12	565	156.5	2.54	50	525	330	435	400	97.46
	550								
13	500	66.0	4.90	65	370	335	415	395	95.10
14	500	107.4	12.80	40	455	305	410	370	87.12

An illustration of the relationship between operating temperature, capacity, and the residual undissociated ammonia in the effluent gas is given in Fig. 3. It is apparent that at 600 and 650 deg. C., a dissociator may operate at full capacity, yielding a gas practically free of undissociated ammonia. Good results may be obtained as low as 550 deg. C., although, below this point the ammonia flow must be considerably retarded to produce a gas having a low ammonia content.

In instances where minute quantities of ammonia are detrimental to the process, the last traces of residual ammonia may be easily and completely removed from the gas by water scrubbing or dry absorption with such substances as anhydrous magnesium perchlorate or ammonium thiocyanate.

Velocity Ratio Chief Factor In Good Mixing of Gases

By THOMAS H. CHILTON and RAYMOND P. GENEREAUX

Experimental Station
E. I. du Pont de Nemours & Company
Wilmington, Del.

IN CARRYING OUT technical gas reactions, it is generally essential to secure thorough mixing of the gases before reaction, in order to obtain the best efficiency. A familiar example is seen in the ordinary bunsen burner, and a more striking case in the surface combustion burner, where all the air is mixed with the gas before combustion. In ordinary burners, however, a slight local excess of gas or air usually will be eliminated during the passage through the flame, and the same quantity of heat will be generated and the same type of atmosphere will result. The requirements of some other reactions are more exacting. Where two or more products can be formed, depending on the relative proportions of the gases, as in the catalytic oxidation of hydrocarbons or the oxidation of ammonia, there will be a loss of yield of the desired product due to a local excess of either gas remaining when the mixture reaches the catalyst. Indeed, there is the possibility in ordinary combustion of the formation of CO or free carbon, in extreme cases. In catalytic processes, analytical control is more exact when samples of mixed gas before and after the reaction can be compared than when over-all yields have to be depended on. Accurate sampling presupposes thorough mixing.

When the gas mixture is produced by saturating a gas with the vapor of a liquid, as by bubbling air through molten naphthalene or passing it through an ammonia stripping column, a fairly uniform mixture is almost bound to result; and when the mixture is carried through considerable lengths of piping or through a preheater, there is likewise little danger of non-uniformity. But when there are reasons why the two gases must be mixed just prior to reaction, a real problem is presented, and it is this case with which we are here concerned.

All kinds of devices have been proposed and used to obtain effective mixing. Some depend on methods of admitting the added gas, others on baffles of various sorts intended to complete the mixing of the two gas streams; but, so far as we are aware, no study has been made of the effectiveness of these devices. The baffles, moreover, often cause considerable pressure drop, and sometimes constitute a "bottle-neck" in the system, limiting its capacity. It was our object in this work to study the effect of different methods of admitting the added gas on the mixing obtained at the point of entrance, to see if good mixing could be obtained without the necessity for further mixing devices.

Presented on Dec. 9, 1930, at the New Orleans meeting of the American Institute of Chemical Engineers, under the title of "The Mixing of Gases for Reaction"; contribution No. 41 from the Experimental Station of E. I. du Pont de Nemours & Company.

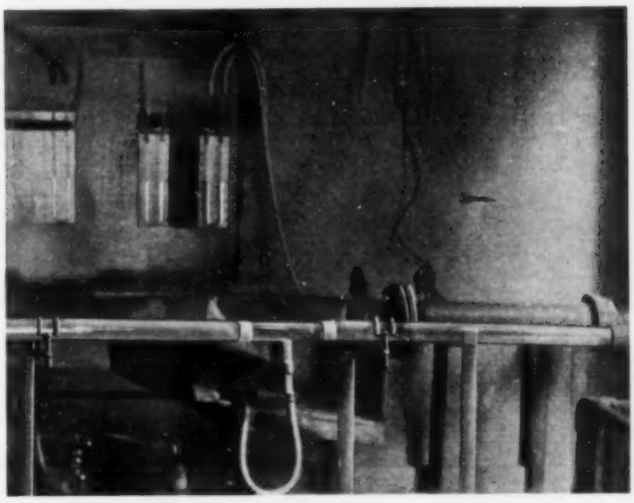


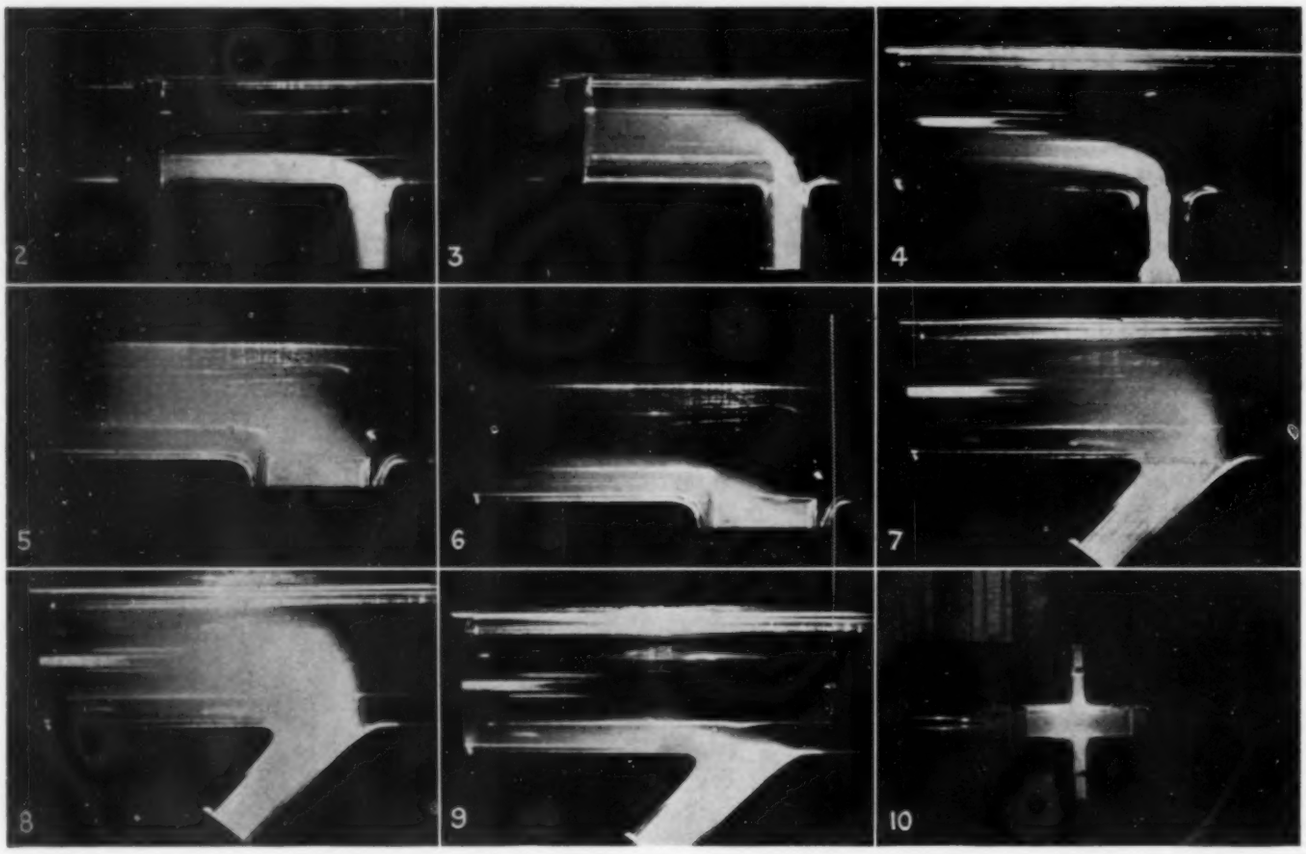
Fig. 1—Set-up of Equipment for Examining Gas Mixing

Our experimental method consisted in observing the flow of two streams of gas (generally air) in glass tubes, with smoke added to make one stream visible. The quality of mixing was judged by the distance downstream from the point of entrance at which the smoke appeared to be completely diffused. Mixing was considered good, for instance, when apparently completed within two or three diameters, and poor when it was evidently incomplete in this distance. Of course, after passage through a sufficient length—15 or 20 diameters—the smoke appeared to be diffused in all cases.

The apparatus used is shown in Fig. 1. The "main stream" of air, measured by an orifice meter, passed through a 1.75-in. glass tube which was in two lengths, so that short sections could be inserted as desired, with side tubes for adding gas or for sampling. As shown in the illustration, there was a length of 15 diameters ahead of the addition tube, to minimize disturbances due to change in direction. The "added gas" was similarly measured through an orifice meter. Connections between the sections of glass tubing were conveniently made with adhesive tape.

Titanium tetrachloride was found to be satisfactory as a smoke-producing agent, after unsuccessful trials of ammonium chloride and fuming sulphuric acid. The following procedure was found to be necessary: a portion of the gas to be added was bypassed through a sulphuric-acid drying bottle, and then over the surface of a little titanium tetrachloride contained in a second bottle. By regulating the amount bypassed, a smoke of any desired density could be secured with any velocity of the added gas stream.

Experiments were carried out originally with visual observation of the gas streams, and qualitative conclu-



Figs. 2-10—Mixing Results as Outlined in Text; Conditions for Each Test Explained in Table IV

Velocity ratios (= velocity added stream ÷ velocity main stream) (2) ratio = 0.5; (3) ratio = 2.7; (4) ratio = 1.6; (5) ratio = 0.9; (6) ratio = 0.15; (7) ratio = 2.4; (8) ratio = 2.1; (9) ratio = 0.35; (10) ratio = 2.1

sions were drawn on the basis stated above. Observation was facilitated by strong illumination of the tube through a narrow slit near the point of entrance, usually in the plane of the axes of the main and the inlet tubes. For record, typical cases were photographed, and some of these photographs are reproduced in Figs. 2 to 22.

Table I—Mixing Two Air Streams With Various Side-Tube Diameters

(Main tube 1.75 in. in diameter)

Side Tube Diameter, Inches	Ratio of Diameters	Lower Limit of Velocity Ratio for Good Mixing	Best Ratio for Good Mixing
0.25	7.0	2.5	3.2
0.50	3.5	2.0	2.7
0.875	2.0	1.5	2.2
1.50	1.16	1.0	1.7

We are indebted to W. Henry Aughey for assistance in developing the photographic technique.

We attempted to determine first the effect of varying ratios of velocities in the main and added streams. This was found to be the controlling factor with any method of admitting the added gas, and even with a simple T-connection, as shown in Fig. 1, apparently excellent mixing can be obtained with the proper ratio of velocities. This is illustrated by comparing Fig. 3, where the linear velocity of the added air stream was 2.7 times that of the main, and Fig. 2, where the ratio of velocities was 0.5. (Table IV *infra* gives the conditions represented by each of the figures; the ratio of velocities is calculated in each case by dividing the velocity of the added stream by that of the main stream.)

The same results were obtained when the actual velocities were varied over as wide a range as the flowmeters would permit, so long as the ratio was maintained constant. With the 0.5-in. inlet tube, the lower limit of good mixing, as judged by our criterion, was at a ratio of velocities of about 2; increase up to about 3.5 still appeared to give good mixing with the best at about 2.7. Ratios between 3.5 and about 6 gave poor or uncertain mixing, since the added stream is carried largely to the farther side of the tube; still higher ratios gave fairly good mixing again, because of rebound of the gas from the opposite wall of the tube. It should be remarked that even when illuminated in a direction perpendicular to the plane of the inlet tube, the mixing still appeared nearly complete after two or three diameters. It seems to be necessary only for the added stream to have sufficient initial momentum to dis-

Table II—Effect of Mixing Air and Various Gases at Several Velocity Ratios

Main Velocity, Ft. per Sec.	Added Velocity, Ft. per Sec.	Ratio Linear Velocities	Main Mass Velocity, Lb. per Sq.Ft. per Sec.	Added Mass Velocity, Lb. per Sq.Ft. per Sec.	Ratio Mass Velocities	Quality of Mixing
			SO_2 and Air			
10.75	14.8	1.2	0.0056	0.0175	3.1	Good
11.6	15.6	1.2	0.0061	0.0184	3.0	Good
11.6	5.8	0.4	0.0061	0.0673	1.1	Poor
			CO_2 and Air			
10.4	16.7	1.6	0.0055	0.0136	2.5	Good
16.5	16.7	1.0	0.0086	0.0136	1.6	Fair
25.5	16.0	0.6	0.0133	0.0131	1.0	Poor
64.5	16.7	0.3	0.0328	0.0136	0.4	Poor
			NH_3 and Air			
11.6	33.2	2.9	0.0062	0.0104	1.7	Fairly good
11.6	27.2	2.3	0.0062	0.0084	1.4	Fair
11.6	22.4	1.9	0.0062	0.0069	1.1	Poor
20.2	35.0	1.7	0.0105	0.0109	1.0	Poor
20.2	16.0	0.8	0.0105	0.0049	0.5	Poor

tribute itself across the main stream before it takes up the new direction.

With other sizes of inlet tubes, the ratio of velocities to obtain good mixing was found to increase somewhat with increasing ratio of main tube to side tube diameter, as shown in Table I. In Fig. 4 is shown a side tube 0.25 in. in diameter, with a ratio of velocities of 1.6, giving only poor mixing. A 1.5-in. diameter side tube, shown in Fig. 5, gives fairly good mixing with a ratio of 0.9; Fig. 6 represents a ratio of 0.15, with poor mixing. It is apparent from the table that a velocity of the added gas 2.5 times that of the main stream can be counted on to give good mixing at the point of entrance.

We then investigated the mixing of other gases with air to determine whether the significant factor was the ratio of linear velocity or the ratio of momentum. The same type of inlet tube was used as in Figs. 2 and 3, with a 0.5-in. diameter. Table II shows the results obtained. With SO_2 and CO_2, the smoke could be introduced with the added gas, and observation was easy. The conditions represented by the second and third lines in the table for SO_2 were photographed and correspond almost exactly with Figs. 3 and 2, respectively. Titanium tetrachloride could not be added with the ammonia gas, and observation with the smoke in the main stream was rather difficult. By comparing Table I, where good mixing is obtained at a ratio of mass velocities of 2.7 (which for two air streams is identical with the ratio of linear velocities), with Table II, where good mixing is obtained with mass velocity ratios around the same value (while linear velocity ratios vary from 1.2 to over 2.9), it is evident that the controlling factor is the ratio of momentum, or of mass velocity, and not the ratio of linear velocity.

To confirm these qualitative observations, experiments were made on mixing oxygen with air at varying ratios, samples of the gas for analysis being taken at three points across the diameter, 8 in. from the point of entrance. The results are shown in Table III. Runs 1

Table III—Mixing Air and Oxygen at Various Velocities

Run No.	1	2	3
Added velocity, ft. per sec.	41.25	16.5	73.5
Main velocity, ft. per sec.	16.5	16.5	17.5
Ratio of linear velocities	2.5	1.0	4.2
Ratio of mass velocities	2.8	1.1	4.6
Ratio of diameters	3.5	3.5	7.0
Quality of mixing, by smoke	Good	Poor	Good
Oxygen per cent, ¼ diam. from top	32.7	21.1	25.0
Oxygen per cent, center line	34.3	28.5	24.5
Oxygen per cent, ¼ diam. from bottom	32.9	32.2	24.0

Figs. 11-22—Mixing Results as Outlined in Text; Conditions for Each Test Explained in Table IV

Velocity ratios (= velocity added stream ÷ velocity main stream) (11) ratio = 0.8; (12) ratio = 6.0; (13) ratio = 1.1; (14) ratio = 2.6; (15) ratio = 1.1; (16) ratio = 1.6; (17) ratio = 5.0; (18) ratio = 2.5; (19) ratio = 0.9; (20) ratio = 1.8; (21) ratio = 1.7; (22) ratio = 2.3

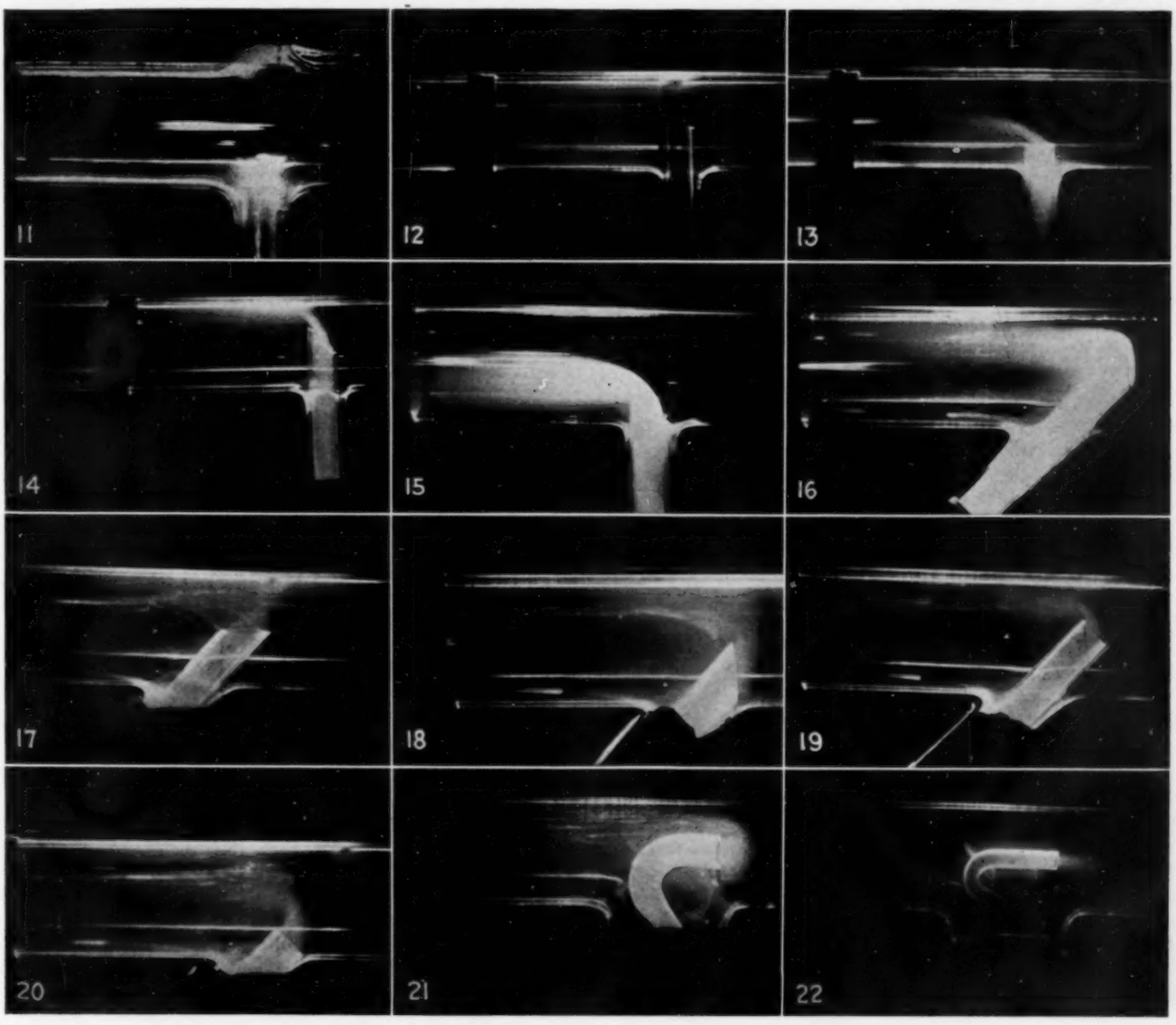


Table IV—Summary of Mixing Conditions on Two Air Streams, Illustrated in Figs. 2-22

Fig. No.	Ratio of Diameters	Main Velocity, Ft. per Sec.	Added Velocity, Ft. per Sec.	Ratio of Velocities	Quality of Mixing
2	3.5	43.0	19.5	0.5	Poor
3	3.5	14.2	37.6	2.7	Good
4	7.0	37.0	58.0	1.6	Poor
5	1.16	8.2	7.5	0.9	Fairly good
6	1.16	48.0	6.9	0.15	Poor
7	3.5	20.2	48.0	2.4	Good
8	3.5	9.0	19.5	2.1	Good
9	3.5	59.0	19.5	0.33	Poor
10	3.5	14.2	29.2	2.1	Good
11	3.5	37.5	30.8	0.8	Poor
12	3.5	4.5	27.2	6.0	Good
13	3.5	18.4	19.5	1.1	Poor
14	3.5	18.4	48.0	2.6	Poor
15	3.5	18.4	19.5	1.1	Some
16	3.5	11.9	19.5	1.6	Some
17	3.5	10.0	51.0	5.0	Poor
18	3.5	14.2	35.5	2.5	Good
19	3.5	21.8	19.5	0.9	Poor
20	3.5	14.2	26.5	1.8	Good
21	3.5	16.0	27.0	1.7	Good
22	7.0	39.0	91.5	2.3	Fairly good

and 2, made with the 0.5-in. inlet tube, confirm the conclusions drawn from visual observations; a mass velocity ratio of 2.8 gives a substantially uniform composition, while a ratio of 1.1 evidently gives poor mixing. Run 3 was made to determine whether good mixing could be secured with the same quantities of gas flowing as in Run 2, by merely increasing the velocity of the added stream by admitting it through a nozzle. The 0.25-in. tube (see Fig. 4) was substituted for the 0.5-in., increasing the velocity ratio fourfold. Qualitatively the mixing was good, though the ratio was higher than that judged to give the best mixing; the analyses are in good agreement, as compared with those from Run 2.

A number of other methods of admitting the added gas were also investigated qualitatively, but none showed any marked advantage over the simple T-connection. Addition of the gas at an angle of 45 deg. pointed upstream, as in Figs. 7-9, affords good mixing at a lower velocity ratio than when added perpendicularly, just as the greatest range of a gun is obtained at an elevation of 45 deg.; the momentum of the added gas is used to best advantage. Good mixing can be obtained with a ratio of 1.5 as a lower limit, with the 0.5-in. addition tube. Both Fig. 7 and Fig. 8 represent velocity ratios in the same range, 2.4 and 2.1, with main stream velocities of 20 and 9 ft. per second, respectively; they thus confirm the conclusion stated above: that the mixing is independent of the actual velocities. The view in Fig. 9 represents a velocity ratio of 0.33; it obviously is poor mixing. Directing the added gas at an angle of 45 deg. downstream makes it more difficult to secure good mixing. With the 0.5-in. inlet tube, good mixing was obtained only in a narrow range of velocity ratios around 2.3.

A multiplicity of perpendicular inlet tubes might prove more advantageous than one, and an arrangement of two tubes diametrically opposite was tested. A somewhat wider range of velocity ratios gave good mixing with this arrangement than with a single tube. In Fig. 10 good mixing appears, being obtained with a velocity in each tube 2.1 times that in the main stream; Fig. 11 shows poor mixing with a ratio of 0.8.

Admission of the gas at the center line, as in Fig. 12, or half way from the side to the center, as in Fig. 13, was found to be disadvantageous, since it was not easy to furnish gas to the lower part of the main stream. With an extremely high ratio of 6.0 (Fig. 12), good mixing is obtained by "rebound" from the wall of the tube. The arrangements shown in Figs. 14 and 15 suffer from the same disadvantage. Admission at the center line, directed 45 deg. upstream (Fig. 16) gives fairly good mixing with carefully adjusted velocity ratios; but the arrangement of Fig. 17 is not helpful. Fig. 19 represents a compromise between these last two. The arrangements shown in Figs. 18 and 20 had no advantage over that shown in Fig. 7.

Injection of the added gas upstream along the axis of the main tube affords good mixing over a fairly wide range of velocity ratios with a 0.5-in. inlet tube (Fig. 21); but the mixing obtainable with a 0.25-in. tube is not so good (Fig. 22). Injection along the axis downstream does not give mixing within two or three diameters, although observation further downstream shows that mixing is eventually completed. There seems to be no advantage in using devices of this sort when better mixing is obtainable by an adjustment of the relative velocities with a simple T connection.

In summary, the effect of different methods of adding one gas stream to another on the degree of mixing obtained has been studied, and it has been found that with an ordinary T-connection, good mixing can be obtained by making the mass velocity of the added stream two to three times that in the main stream.

▼ ▼

Binary Chemical Cycle Proposed For Power Generation

IN ITS ISSUE of Oct. 28, 1930, *Power* published an article based on an interview with a German engineer, Dr. Ing. E. Koenemann, who has proposed a binary power generation cycle employing ammonia and an ammonia carrier in the primary stage and steam in the secondary stage. The advantage of this over the mercury-steam cycle now in successful operation at Hartford, Conn., is said to lie in greatly reduced investment.

Dr. Koenemann's process depends on the fact that the compound $ZnCl_2 . 2NH_3$ loses one molecule of ammonia at high temperatures, while the resulting $ZnCl_2 . NH_3$ vigorously takes up a molecule at a lower temperature. The first effect is endothermic and the second exothermic. When the di-ammonia salt is heated in a boiler, it melts, and in a typical case, gives off ammonia at 100 lb. abs. pressure and 896 deg. F. After the ammonia has produced power in a turbine, it is exhausted at 239 deg. F. and 1 lb. abs. to a jet condenser "mixer" where it combines exothermically with some of the ammonia-depleted compound which has been cooled in a heat exchanger. The recombined compound at 444 deg. F. is used to generate steam for a conventional steam cycle before it is returned to the boiler. Dr. Koenemann's calculations show the result to be a fuel saving of over 29 per cent, and a reduction in cooling water of 40 per cent.

Correction: Our attention has been called to an error which was made in reproducing the charts given by Mr. Halferdahl in his article "Specific Heat Charts for Gases," appearing on pages 686-7 of our November, 1930, issue. Although the abscissas of the charts are correctly described in the accompanying text, they are incorrectly given on the main charts as "$t_a - t_b$." Instead, these should read "$t_a + t_b$." On the other hand, the abscissas of the small correction charts for $(t_a - t_b)$ are correct.

Viewing the Fundamentals of Three-Roll Grinding

By G. A. VASEL

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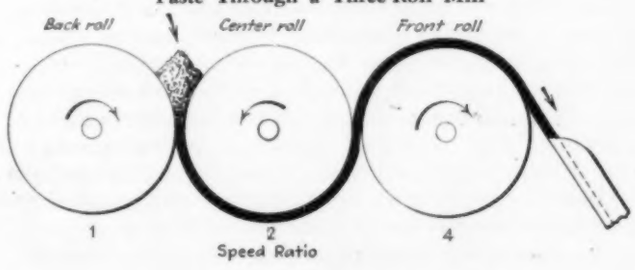
For more than a century of extensive use this basic production tool was taken for granted. Mr. Vasel's careful analysis, coming as it does after his several years' research on the three-roll mill, will prove enlightening to both present and prospective users.

FINE GRINDING by means of the three-roller mill is a method of considerable antiquity. It is not known when this principle was first used, but it is certain that it has been well known for more than a century. It is believed that stone was the most common material for rolls in the early machines. About 75 years ago, the first cast-iron rolls came into existence. They were solid and it was impossible, of course, to cool them internally with circulating water. About 30 years ago the first hollow iron rolls were built to make water cooling possible. This has been the only major improvement in the conventional type of mill that has appeared since metal was originally substituted for stone.

Roll grinding may be defined as a means of producing a fine state of subdivision in solids, and dispersing the particles in a vehicle, by means of pressure and attrition between rolls which are moving at different speeds. The subject should be distinguished from roll crushing, which is a much cruder form of grinding and one used principally for the primary subdivision of lump materials of much larger particle size than is met in roll grinding. The present article deals only with the latter form of disintegration.

Theoretically, roll grinding may be accomplished on two or any greater number of rolls. Actually, for most purposes, the three-roll mill is most satisfactory. In such a mill, material receives two grindings in a single passage through the machine. If the mill had two rolls, material would receive but one grinding. It is obvious that the three-roll mill permits twice the grinding with only one additional roll. In the case of mills using more than three rolls, the grinding advantage is not increased. In a five-roll mill, for example, material obtains four grindings in a single pass. Although it might seem desirable, because of reduced handling of material, to use a greater number of rolls than three, it will appear later that the difficulties attendant upon proper adjustment of pressure between the rolls so complicates the use of a machine having more than three, that the advantage is doubtful.

Illustrating, in Exaggerated Manner, Passage of Paste Through a Three-Roll Mill



A typical three-roll mill consists of a framework supporting three hollow, chilled cast-iron rolls arranged to permit internal water cooling. The rolls are geared together so that their speed of rotation is in some constant ratio, ordinarily 1 : 2 : 4. No one knows just why this ratio was chosen, and there appears to be no scientific basis for its choice. It is, nevertheless, standard and is used in practically all three-roll mills. The author is now engaged in work which will indicate whether this ratio has any advantage other than precedent.

The supporting framework for the rolls incorporates mechanism for pressing the rolls together. In the conventional type of mill, this consists of handwheel-operated screws which are used to apply pressure to the rolls at the bearing points, forcing the two outer rolls against the center roll. The first, or "back," roll travels at the lowest speed, and the third, or "front," roll at the highest speed. Material placed between the back and center rolls passes down through the region of contact, forming a thin film on the center roll. As this film is scrubbed by the front roll, it is removed by the latter, from which it is scraped by a knife attached to the discharge apron. The differential speed between rolls results not only in attrition but in forward motion of the material through the mill.

As solids pass through either contact area, it is evident that the pressure on the rolls crushes the particles, while at the same time the differential speed of the roll surfaces produces a shearing action. It is not yet known what differential speed is most suitable for any given material, but it has been definitely established that the relation between pressure and material must be carefully determined for optimum results. It seems likely that the pressure on the particles, rather than the attrition, is the factor of greatest importance in determining the reduction, although differential speed is, of course, necessary to cause passage through the mill. When two rolls are in contact, the major part of the material will pass from the lower speed roll to the higher speed roll.

It is well at this point to define the scope of roll grinding. The method is primarily adapted to the deflocculation and dispersion of agglomerated particles, and the reduction of small particles to still smaller sizes. Roller mills are strictly secondary disintegration machines. Not only so, but they are precision machines and require intelligent care in their operation.

Size reduction obtainable on roller mills depends on a number of factors, but generally it is possible to approach sub-microscopic dimensions for a considerable part of the output of the mill. Such fineness, however, is often not required. One factor that may limit the possible size reduction is surface porosity of the rolls, which may be sufficient to prevent very fine grinding.

Highly abrasive materials should not be ground on roller mills. Less abrasive materials, suspended in a vehicle having lubricating properties, may be handled ordinarily without difficulty. As a general proposition, the dispersing medium should be a fairly good lubricant. As an indication of the range of roller mills, it may be mentioned that most pigmented products may be ground in this manner. These include inks, artists colors, paints and enamels, colors for leather, and colors for filling fabrics. Mills of this type are also used in producing hard soaps, certain cosmetic materials, and tooth pastes. In food manufacturing, roller mills find application in the production of chocolate and peanut butter.

Performance of a three-roll mill on any given material is dependent on a considerable number of variable factors. Among the most important of these are pressure between the rolls; speed of the rolls, both absolute and relative; roll diameter; feed and operating temperature; rate of feed; height of feed between the rolls; fluidity of the feed material; affinity of the solids for the vehicle; characteristics of the rolls and other parts of the machine; number of passes through the machine; and other features of less importance.

Of these, pressure unquestionably is of greatest moment. With the conventional mill, the skill of the operator determines how nearly at optimum conditions the pressure can be controlled. Actually, even a skilled operator has very little idea of the pressure between rolls; and he may even permit large differences in pressure from point to point along the rolls.

What is needed obviously is some accurate method of determining the pressure between the rolls, and ability to maintain this pressure at a point indicated by experiment as most satisfactory. How this is accomplished is of small importance, as long as it is reasonably infallible. No operator, unaided, can be expected to judge pressure with reasonable accuracy. The author has demonstrated conclusively that variation in pressure will produce widely varying results in grinding. Operating a conventional mill, a good operator usually can grind a product to the desired consistency and fineness. But it has often been shown that this same material can be ground to equal or better fineness and uniformity in fewer passes on a mill in which the roll pressure can be controlled.

NOT ONLY must the pressure be optimum at any given point between the rolls but it is absolutely necessary that it be uniform from point to point along the rolls. Otherwise, material will be squeezed out of a region of higher pressure into a region of lower pressure, resulting in the utilization of only part of the roll surface and in material reduction in the grinding capacity of the machine. Assuming, then, that the pressure is constant along the rolls—i.e., the rolls are in perfect parallelism—the manifestations of pressure are fourfold. In the first place, the resulting reduction in particle size is primarily dependent upon pressure. Within limits, the greater the pressure, the greater the reduction in particle size for a single pass through the rolls. The term "within limits" is used advisedly, however, since if the pressure be made sufficiently high, material will not pass between the rolls, and there will consequently be no reduction.

As an example of the effect of pressure variation, one case may be cited. It was desired to grind a mixture of 50 per cent lithopone and 50 per cent vehicle. On the first pass through the mill, a certain weight of the material was reduced to 98.74 per cent through a 325-mesh screen. In this case the gage pressure on both front and back rolls was 75 lb. The pressure was then increased to 100 lb. on the back roll and 150 lb. on the front roll, and an equal weight of the same material was passed once through the rolls, yielding a product 99.74 per cent through a 325-mesh screen.

ANOTHER effect of pressure is on the output. Considered from the angle of a single pass through the mill, increasing pressure obviously decreases the output. For example, in the foregoing case, the grinding time at the lower pressures was 13 minutes. At the higher pressures, the same weight of material, with all conditions except pressures identical, was 27 minutes. On the other hand, when the problem is considered from the standpoint of the several passes that must be made through the mill, in order to produce a finished product, it will then be found that output will increase with increasing pressure to a certain maximum value, whereupon further increase will gradually reduce the output to zero.

Still another effect of pressure is the generation of heat. In general, increased pressure results in increased heat generation, although this will vary with the material, the quantity and kind of vehicle, and with the speed of rotation. And finally, pressure may be raised to such a value that it will have the effect of separating solids and vehicle. Whether such a pressure can be reached will depend on the characteristics of the materials.

It is evident, therefore, that the most suitable pressure for any given material will be a compromise between various factors. Size reduction, output, and permissible temperature rise in the product must all be taken into consideration. Optimum conditions can be determined only as the result of experiment, and will be found to vary with the solids, the vehicle, and the reduction. And since it is rare that the same pressure is suitable for both front and back rolls, these pressures must be determined individually. When we consider the far-reaching aspects of pressure in roll grinding, it becomes apparent why increase in the number of rolls above three greatly complicates the problem of maintaining optimum conditions.

Speed of the rolls is another variable which is important in securing satisfactory roll grinding. It is not surprising that the relative peripheral speed of adjacent rolls should have considerable bearing on the results obtained. But it is not at all obvious that the absolute peripheral speed of the rolls should have an effect, other than on quantity of production. It has been demonstrated, however, that the product improves with greater absolute speed, for this results in increased fineness and uniformity of grinding. This has not generally been believed, although its truth has recently been demonstrated by the author. Apparently, the explanation lies in the increased turbulence of material as its enters the zone of contact between the rolls. This factor of increased turbulence points to another important element in roll grinding. I refer to the mixing which the ingredients receive prior to milling. Thorough mixing is an absolute necessity. Every particle must be thoroughly wetted by the vehicle. Obviously, the more mixing the grinder is called upon to do, the smaller its capacity will become.

Third in the list of important variables is temperature.

Except in the few cases where a vehicle, such as a wax, is solid at ordinary temperatures, and must be kept hot to preserve sufficient fluidity, the rolls will require cooling. A great deal of work is done in reducing particles to colloidal dimensions, and this heat must be largely removed. Water ordinarily is satisfactory for this purpose, although occasionally brine cooling is resorted to.

In the main, the most satisfactory feed temperature will range between 80 and 100 deg. F. It is not often permissible to allow the temperature of the material to increase more than 10 or 15 deg. in passing through the mill. In many cases temperature increase will yield results deleterious to the material; perhaps a change in color, or in composition. On the other hand, even when the material will not be adversely affected by increasing temperature, expansion of the rolls may cause difficulty, and it may be given as a general rule that considerable temperature rise should be avoided.

MORE important than reducing the temperature rise to small magnitude is the maintenance of uniform temperature along each roll. Various factors may give rise to a higher temperature at one point than at another. If the pressure of the rolls be greater at one end than at the other, this will produce a higher temperature at the point of greater pressure. Another frequent cause of difficulty is the friction resulting from rubbing of the side plates on the rolls. To prevent material overflowing the ends of the rolls at the feed end, it is necessary to introduce plates between the rolls to limit the spread of the material. When these plates are in contact with the roll surfaces, they are likely not only to wear the rolls at the point of contact but also to raise the temperature and increase expansion non-uniformly.

Operating temperature of the rolls is considerably affected also by the manner in which the mill is fed. Without exception, the feed to the mill should be uniform from end to end. If the material being ground is not sufficiently fluid to spread—and it frequently is not—then the feed must be distributed by hand, or otherwise, in as uniform a manner as possible. If the feed is irregular, roll temperature will decrease at the points of greater feed, causing lower pressure at these points and faulty grinding. Poor feeding has been responsible for a great deal of trouble. Another of its manifestations arises from a lack of a definite and frequent feeding schedule. Where one operator has charge of several mills, his practice usually is to load one mill as high as possible, after which he goes on to the next. When he finally returns to the first mill, it probably will be empty. Strange as it may seem, the height of material between the back and center rolls has a considerable influence on the performance of the mill. Wide variation in this head not only changes the character of the grinding but alters the roll temperature, making uniform results impossible.

Another factor is fluidity. The object of roll grinding is to reduce and disperse solid particles, not to grind vehicle. When there is more vehicle present than is necessary to provide sufficient lubrication, the inevitable result is reduction in roll capacity. No general rule can be laid down for the proper quantity of vehicle, other than to say that it should be the smallest quantity which will operate satisfactorily. It is not necessary that the material be sufficiently fluid to flow like a liquid. Pastes are capable of satisfactory handling on the roller mill. It will often be found desirable to grind with less vehicle than is needed in the finished product, making up the deficiency after the grinding has been completed.

Inaccuracies in the rolls and other peculiarities of the machine are among the most annoying variables that can be encountered in this method of grinding. Wear of the roll surfaces near the ends, due to friction of the side plates, has already been mentioned as one source of inaccuracy. Improper pressure adjustment may give rise to others. Suffice it to say, however, that if the rolls be as accurate as possible in the first place, if pressure be maintained uniformly at all times along the length of the rolls, if wear due to contact with the side plates and the apron knife be eliminated, and if the rolls be driven from both ends, thus eliminating unnecessary distortion, their useful life is very great.

The number of passes that a material must make, before it has reached a satisfactory state of dispersion and fineness, is intimately tied up with variables which have been discussed. It is not generally possible to predict how many passes will be necessary for any given material. Nor it is possible to predict the required pressure, or the output. Nevertheless, if the optimum pressure be maintained for any given material, the number of passes and the rate of output of the mill are fixed. The first pass through the mill is the one of greatest importance. If the reduction in this pass be either too great or too little, various results are possible. Proper reduction may never be obtained in a reasonable number of passes, output may fall off, vehicle may be squeezed out of the solids, or the degree of dispersion may be unsatisfactory. It is very important that the proper choice be made of grinding conditions for the first pass in determining procedure with any new material.

Formerly it was supposed that the length and diameter of the rolls had no particular bearing on the performance of a roller mill. Constructional difficulties kept the maximum roll size down to 16x40 in. Recently, however, it has been possible to build three-roll mills with 20x60-in. rolls. Where production is sufficient to justify such a large machine, it has decided advantages over the use of two or more mills of equivalent total capacity. For one thing, an operator can tend a single mill more carefully than he can several, and the resultant product will be better. Again, power consumption and floor space are considerably less. There is still another effect apparent, however, in comparing any size of roll with a larger size. It has been demonstrated that the output is increased somewhat more than proportionally by increase in roll diameter. This is apparently explained by the fact that the area of contact between larger rolls is greater for any given pressure than for rolls of smaller diameter.

THESE principles make it possible to set up the principal requirements for a satisfactory roller mill. First and most important, it should be possible to determine the pressure between rolls and to maintain this pressure at a reasonably constant figure during the grinding. In the mills designed by the author, pressure is applied hydraulically and registered on pressure gages (see *Chem. & Met.*, November, 1930, p. 703). It should be possible to cool the rolls, to prevent distortion from unequal heating, and from driving stresses. The rolls should be true and the necessity for redressing should be avoided to preserve the surface hardness. Roll parallelism must be maintained at all times, and uneven wear of the surfaces must be eliminated. High speed is a requirement for large capacity, and the machine must permit this without undue noise or vibration. A mill meeting these specifications will give long life, high capacity, and a satisfactory and reproducible product.

READERS' VIEWS AND COMMENTS

An Open Forum

The editors invite discussion of articles and editorials or other topics of interest

Specific Heats of Gases

To the Editor of Chem. & Met.:

Sir:—Who is right on the specific heats of gases? In your November issue, A. C. Halferdahl gives some new graphs for the specific heat of gases at high temperatures based on equations given by E. D. Eastman of the U. S. Bureau of Mines. These equations do not agree in the least with data of the International Critical Tables compiled by Profs. T. H. Laby and E. O. Hercus. Surely the data in the International Critical Tables represent a critical survey of all existing experimental data.

For comparison I am tabulating three sets of equations: (1) Derived by G. N. Lewis—Lewis and Randall, Thermodynamics, 1923; (2) By E. D. Eastman—U. S. Bureau of Mines Tech. Paper 445 (1929) as reported by A. C. Halferdahl; (3) Equations based upon data given in the International Critical Tables, Vol. V, 1929.

Equations are all given for molal heat capacities in calories per kilogram-mol per degree Centigrade, at a constant pressure of one atmosphere. Temperatures are given in degrees Kelvin. These equations do not hold for temperatures below 0 deg. nor above 2,000 deg. C.

Hydrogen

(1) $6.50 + .0009T$
(2) $6.85 + .00028T + .00000022T^2$
(3) $6.630 + .000716T$

Nitrogen, Carbon Monoxide, Oxygen

(1) $6.50 + .001T$
(2) $6.76 + .000606T + .00000013T^2$
(3) $6.942 + .000000308T^3$

Carbon Dioxide, Sulphur Dioxide

(1) $7.0 + .0071T - .00000186T^2$
(2) $7.70 + .0053T - .00000083T^2$
(3) $7.189 + .0057T - .00000137T^2$

Water Vapor

(1) $8.81 - .0019T + .00000222T^2$
(2) $8.22 + .0001T + .00000134T^2$
(3) $9.66 - .00314T + .00000259T^2$

Ammonia

(1) $8.04 + .0007T + .0000051T^2$
(2) $6.70 + .0063T$

Methane

(1) $7.5 + .005T$
(2) $5.90 + .0096T$
(3) $2.393 + .0234T - .00000433T^2$

Chlorine

(1) $7.4 + .001T$
(2) $8.58 + .0003T$

The Eastman equations seem to give values which are much too high for carbon dioxide, water vapor, and the nitrogen group, too low for methane and slightly high for hydrogen. But all three sets of equations are supposed to be based upon the best existing experimental data. Because of the tremendous value of heat capacity data of gases some decision should be made concerning the relative reliability of these three sets of equations.

O. A. HOUGEN.

Associate Professor of Chemical Engineering
University of Wisconsin, Madison

Responsibility in High-Pressure Research

To the Editor of Chem. & Met.:

Sir:—In the September issue of *Chem. & Met.* an article (page 534) describes the high-pressure research facilities of universities and government laboratories in the United States. Although in practically every case the specific material relating to individual laboratories was obtained from the present directors of the work, the mention of active personalities in this research failed to include the names of Per K. Frolich, now of the Standard Oil Development Company; Ralph L. Brown, now with the Atmospheric Nitrogen Corporation; and A. E. Galloway, now of the Selden Company. This regretted omission refers in the case of Dr. Frolich to the important work on high pressure done while at Massachusetts Institute of Technology, and, in the case of Dr. Brown and Mr. Galloway to the work explained in the attached letter.

This also offers occasion to emphasize the fact that the article on pressure-vessel design in the same issue (page 540) was based almost entirely on technical data and curves supplied by the A. O. Smith Corporation, of Milwaukee. Although acknowledgment was made in my article, due credit is gladly repeated because in several instances the source of the material has seemed unclear.

Division of Chemical Engineering, NORMAN W. KRASE.
University of Illinois,
Urbana.

To the Editor of Chem. & Met.:

Sir:—In the September issue of *Chem. & Met.* an article, "Research That Paved the Way for a New Technology," describes the researches and research equipment at various universities and government laboratories. With respect to the high-pressure and methanol work at the Bureau of Mines station in Pittsburgh, the records will show: (1) that the methanol work in the Bureau of Mines was begun by the Organic Chemistry Unit about the beginning of 1926; (2) that all the high-pressure studies on the synthesis of methanol and methyl ether from CO and hydrogen were carried out by that unit under the supervision of the organic chemist; (3) that at no time was that work, which was carried out by Mr. Galloway and myself, a part of the work of the physical chemical section and it was not under the supervision of that section.

On the other hand, the physical chemical section, beginning about September of 1926, entered into the field with its program of studies, at or near atmospheric pressure, which has included methanol decompositions, the methanol equilibrium, the synthesis of hydrocarbons from water gas, and the like. R. L. BROWN.

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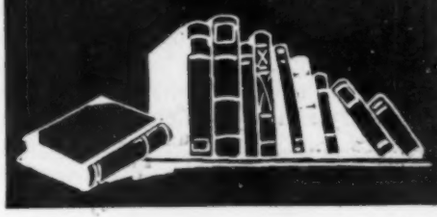
CHEMICAL ENGINEER'S BOOKSHELF



The Useful Diatom

DIATOMACEOUS EARTH. By *Robert Calvert.* Chemical Catalog Company, New York. 1930. 251 pages. Price $5.

Reviewed by PAUL D. V. MANNING

BY REASON of his experience while in charge of the research laboratory of the major producer of diatomaceous products, the author is well equipped to summarize the present-day knowledge of the subject, "interpret the literature in the light of experience," and describe the industry.

In his preface, Mr. Calvert points out some very interesting facts which the reviewer feels are especially worthy of note. The value of diatomaceous earth is due to the combination of small size, physical structure, and chemical composition. Forty million of one variety are required to make up a cubic inch. Each individual is highly channeled, perforated, and has a large surface. Use began as early as 532 A.D. and later diatomite made possible the invention of dynamite, though these uses have not survived. "As with Nobel's dynamite, so also with many of the newer uses, the name of the finished product does not suggest the importance of this earth as a raw material or as an aid in the manufacture. Even diatomaceous filtration powders and thermal insulators bear such trade names as to conceal the true identity. In spite of such handicaps of secrecy, the applications of the earth are being extended rapidly to new industries," and production by this distinctly American industry is at present twenty times that of 1900. It is used "by more than half of the large chemical manufacturers" and "nearly all modern steam plants."

That diatomaceous earth is of vegetable origin from microscopic plants will, no doubt, surprise many readers not familiar with the industry. It is not to be confused with infusorial earth and other such substances.

The introductory chapter of the book covers the literature of diatoms, while a second sums up the industrial uses and gives world production figures. Occurrence of the material throughout the world is treated and analyses of various deposits are given. A chapter on mining and preparation of the earth includes methods of testing and selecting the material. Another chapter discusses physical properties.

The subject of filtration is taken up in great detail and this will be of special value to the chemical engineer, because there are included not only methods of manufacture and preparation but also the application of the finished product to filtration problems in the manufacture of sugars, corn products, vegetable oils, fruit juices, soaps, and so on. Included also are its applications to such industries and uses as sewage disposal, metallurgical slimes, milk, petroleum, rubber, electrical heat insulation, cement, and a host of others, thus fully justifying the author's prefacial statement that this material finds use in the majority of industries.

The textual content is interesting and it is well written, in readable style. Many illustrations, selected with care, also evidence the fact that the author has produced a finished article. As a chemical engineer, you will find something of interest on your own pet industry here.

The Scientific Outlook

SCIENCE AND THE SCIENTIFIC MIND. By *Leo E. Saidla* and *Warren E. Gibbs.* McGraw-Hill Book Company, New York, 1930. 506 pages. Price, $3.

Reviewed by J. R. VAN ARSDALE

THESE teachers of English have assembled between the two covers of this book the outpourings, at once provocative and stimulating, of a score of "scientific minds." Planned primarily as a textbook in advanced composition for students of science and technology, the work merits wider consideration. For the most part those whose "contributions" are here collected are men of an interpretive turn of mind—specialists, in the sense of possessing an uncommon grasp of the tedious gropings of science through the ages, yet charitable enough to render their expositions convincing to men of lesser knowledge.

In a time like ours, when the popular mind, belabored by much pseudo-scientific buncombe, inducts the word "science" into its glib vocabulary and bids fair to make a fetish of it, those possessed of even a modicum of intellectual pride will welcome an effort to define more exactly the implications of the term. "Science and the Scientific Mind" is such an effort, and a commendable one.

Here are to be found as many approaches to the book's title theme as there are disciplined imaginations contributing. No consideration of the fertile ideas of John Tyndall, or J. W. N. Sullivan, for instance; or Arthur Schuster, or Frederick Soddy, or J. S. Haldane can leave one without a feeling of having added at least a cubit to his intellectual reach. Often one feels constrained to release one's awakened interest in some newly disclosed idea to graze beyond the necessary limits of this collection. This possibility the authors have foreseen and provided for in Appendix C, a list of "Suggested Readings in the Literature of Science."

This volume is a well-conceived emulation of "tough-mindedness" as counterdisposed to "tender-mindedness," to use Henry James' classification of metal characteris-

tics. Since students of science and technology are presumed to be dominantly tough-minded, it probably borders on the ridiculous to hope that this volume may be followed by an equally capable exposé of the qualities, meanings, procedures, and influences of tender-mindedness.

Data Under High Pressure

MECHANICAL ENGINEERS' HANDBOOK. Third Edition. *Lionel S. Marks,* Editor in Chief. McGraw-Hill Book Company, New York, 1930. 2264 pages. Price, $7.

Reviewed by THEODORE R. OLIVE

A THIRD edition of the "Mechanical Engineer's Bible" has put in an appearance. Since 1924, when the second revision was made, many changes have taken place, even in such a settled and sedate profession as mechanical engineering. That this has been recognized by the editors is well attested by seven new sections, including among other subjects, high- and low-temperature carbonization, refractories, and electric furnaces. Some 16 sections have been completely rewritten, and many more have had the benefit of considered revision. Among these are many of the subjects with which the chemical engineer must have at least a handbook acquaintance.

A reference work as well known as Marks' needs no detailed account of contents. Obviously, one's immediate estimate: "a little bit of everything, and a lot about a good many things," errs on the side of universality. Even Marks misses an occasional trick in subjects quite alien to mechanical engineering. Nevertheless, this reviewer sees ample justification for a course he has long followed, of first taking almost any engineering problem to Marks. More frequently than not this ends the search.

ABEGGS HANDBUCH DER ANORGANISCHEN CHEMIE, Iron and Its Compounds. By *R. Abegg, F. Auerbach,* and *I. Koppel.* S. Hirzel, Leipzig, 1930. 463 pages. Price, 45 M.

THE EARLIEST volume of this very valuable handbook appeared a quarter of a century ago; only now do we get a part dealing with the element iron, an indication of the difficulties encountered in the endeavor to give a critical survey of what is known of the chemistry of iron. The present part discusses the ferro- and ferrisalts (excluding the complex cyanides, and the sulphides, carbides, etc., which belong more properly with the metal iron), the ferrates, carbonyls, and nitronyls. It seems to be fully up to the high standard set by the earlier volumes.

THE ENGINEER'S VEST POCKET BOOK. By *W. A. Thomas.* W. A. Thomas Company, 4554 Broadway, Chicago, Ill. 1930. 151 pages. Price, $3.

HANDBOOKS achieve individuality by becoming either much larger or much smaller than their competitors. This book is of the latter persuasion; with its india paper and flexible binding, it is so small, in fact, that the quantity of its really valuable contents is a source of constantly increasing surprise to one who thumbs it through. In the course of 150 pages it sets out to hit the high spots of engineering in general. That it has attained even a measure of this aim is a tribute to the power of selection of its author.

Once the reader has accustomed himself to a feature of novelty for which no good excuse seems to exist, namely, the hand lettering of all of the material, text as well as illustrations, he is in a better position to appreciate the range of the contents. In 12 divisions we pace rapidly through mathematics, statics and dynamics, strength of materials, construction, mechanical design, heat, hydraulics, chemistry and physics, electricity, transportation, surveying, cost, and general. For the engineer who has need of a handbook away from his desk, this little work is certain to be of value.

Recent Arrivals

ALLEN'S COMMERCIAL ORGANIC ANALYSIS. Vol. VIII, 5th edition. Edited by *C. Ainsworth Mitchell* and numerous contributors. T. Blakiston's Son & Company, Inc., Philadelphia, Pa., 1930. 761 pages. Price, $7.50.—The latest volume in the growing fifth edition covers glucosides, by Julius Grant; enzymes, by Julius Grant; putrefaction bases, by G. Bearger; animal bases, by K. George Falk; animal acids, by Philip B. Hawk; cyanogen and halides, by J. H. Buchanan; proteins, by S. D. Schryver; and digestion products of protein, by S. D. Schryver.

CHEMICAL PROGRESS IN THE SOUTH. Compiled by Division of Chemistry and Chemical Technology, National Research Council, *J. E. Mills,* chairman. The Chemical Foundation, Inc., New York, 1930; 282 pages.—Compilation of articles that appeared originally in the *Journal of Chemical Education,* by various authorities. It is divided into sections on educational institutions, chemical problems, recent developments, statistical information and library facilities.

ORIGIN AND DECOMPOSITION OF ORGANIC SULPHUR COMPOUNDS, under gas-making conditions, with particular reference to the rôle of the carbon sulphur complex. By *John C. Holtz.* Dissertation presented for Ph.D. degree at Johns Hopkins University, Baltimore. 83 pages. Price, $1.—The length of the title is in keeping with the wide range of problems covered; carbon bisulphide is submitted to a thorough investigation, and gas-making applies here to oil as well as coal processes.

FIVE YEARS OF RESEARCH IN INDUSTRY, 1926 to 1930. Compiled by *Clarence J. West.* National Research Council, New York, 1930. 91 pages. Price, 50 cents.—A bibliography of selected articles from the technical press, grouped according to industries and designed to answer questions on research. It also indicates in which fields industrial research is lacking.

FORMATION AND PROPERTIES OF BOILER SCALE. By *Everett P. Partridge.* Bulletin No. 15, Department of Engineering Research, University of Michigan, Ann Arbor. 170 pages. Price, $1.—The second recent outstanding study on this subject, it presents what is known about scale formation rather than makes a new attack on the problem of scale prevention.

ALBERTA: GEOLOGY AND WATER RESOURCES. By *Ralph L. Rutherford.* Geological survey division, Province of Alberta, Edmonton, Canada, 1930. 68 pages, with plates and large map. Price, $1.

AN OUTLINE FOR MARKET SURVEYS. Prepared by *George C. Smith.* Published by the Industrial Club of St. Louis, 1930. 85 pages.—An outline and interpretation of what the 1930 distribution census has revealed, containing statistics, maps and a bibliography.

CONDENSATION OF BINARY MIXTURES AND THE CALCULATION OF RECTIFYING APPARATUS. By *Emil Kirschbaum.* Dechema, Monograph No. 12, Vol. 2. Verlag Chemie, Berlin, Germany, 1930. 40 pages. Price, 5M.—One of the series of published papers presented to the German Society for Chemical Apparatus.

SELECTIONS FROM RECENT LITERATURE

ELECTROLYTIC TIN. F. Foerster and H. Deckert. *Zeitschrift für Elecktrochemie,* November; pp. 901-23. In the electrolysis of acid stannous sulphate solutions, the tin deposited at the cathode has a tendency to come down in needle-like growths, perpendicular to the plane of the cathode. Crude m-cresol sulphonic acid is an effective agent for suppressing this tendency and causing the tin to deposit smoothly and evenly. It has been found, however, that the active agent is not m-cresol sulphonic acid itself but certain impurities associated therewith. These impurities are in true solution in the electrolytic bath, and exert their influence by reason of being adsorbed on the tin. If the cresol is sulphonated above 120 deg. C., there also are formed colloidal impurities which contribute little or nothing to the electrodeposition result. There are other substances which are adsorbed by tin and which exert a favorable influence on the form of the deposit; among them is pure m-cresol sulphonic acid itself, if present in a sufficiently high concentration. Others are the sulphates of aniline and pyridine; certain phenols, and gelatin. The adsorbable impurities in crude sulphonated cresol, however, are effective in very small concentrations. When the electrolyte is stannous chloride instead of stannous sulphate, the same effect occurs but is much less pronounced, so that it is difficult or impossible to find a sufficiently effective concentration. Photo-micrographs are shown, to illustrate the relation of adsorption to the form of the deposit.

WELDED APPARATUS. H. Holler. *Zeitschrift des Vereins deutscher Ingenieure,* Nov. 15; pp. 1579-84. Builders and users of chemical plants were among the first to bring about real advances in welding practice, and they have continued to contribute to the art by setting up specifications in keeping with progress made in plant design and construction. Acetylene welding is now successfully applied to both the ordinary and special (acid- and heat-resisting) steels, and also to non-ferrous metals, including aluminum, copper, brass, bronze, nickel, and silver. All of these metals have their own uses in contributing to the durability of chemical apparatus. The physical and chemical requirements of the chemical industry for welded unions are high, but they are being successfully met, thanks to intelligent planning, forethought, and co-operation between welder and user. One result of this improved practice is that riveted and bolted unions are now being avoided wherever possible, and the necessity for them is decreasing as the welding art advances. For each of the kinds of metal discussed, a brief practical statement is given of factors to be considered, such as choice between fusion and hammer welding, treatment of the metal before and after welding, etc. Photographs and diagrams of large units of chemical apparatus are shown, to illustrate welding as a structural detail. Repair jobs also are considered.

AEROSOL AND AEROGEL CATALYSTS. W. E. Gibbs and H. Liander. *Transactions of the Faraday Society,* November; pp. 656-62. Some of the more recent advances in the theory of heterogeneous catalysis point toward the conclusion that the best catalytic effect may be expected when the catalyst is introduced into the system in the nearest approach to molecular dispersion. This ideal approaches the conditions which prevail in homogeneous catalysis. To test this reasoning, trials were made in hydrogenation of carbon monoxide with the aid of nickel catalysts prepared in the form of aerosols or aerogels of nickel. An aerosol made by condensation of nickel vapor showed no catalytic activity; but the catalyst concentration was low, so another trial was made in which a higher concentration was obtained by making the aerosol by decomposition of nickel carbonyl in the gas to be treated. This method gave a dense nickel smoke, but there was practically no catalytic effect. The cause in this case might be poisoning of the catalyst by the nascent carbon monoxide which was to be hydrogenated. Adsorption experiments with a nickel aerogel and nascent carbon monoxide showed that nickel in this form has little or no adsorption capacity for carbon monoxide, although the metal is in such a fine state of division as to have an enormous surface area. The aerogel differs from the aerosol in that it has some catalytic activity; but at best it could only be considered as a second-rate catalyst. The experiments do not therefore reveal any prospect of improvement in catalytic processes by using the catalyst in the form of aerosols or aerogels.

THERMAL PROPERTIES OF TOLUENE. K. Nesselmann and F. Dardin. *Zeitschrift für technische Physik,* November; pp. 487-91. For a comparison of toluene vapor with steam as a means of motive power, careful measurements have been made of the specific heats, heat of vaporization, entropy relations, heat capacity, and isobars of toluene and its vapor. Equations are derived, but they are not capable of extrapolation, and so it is not yet possible to draw a complete Mollier diagram for toluene vapor. It is shown, however, that toluene could be successfully used as the working medium in the Benson process, because no intermediate superheating of the vapor would be necessary, the critical pressure being only 43 atm. and a very slight superheating being sufficient to avoid the condensation region in releasing the pressure from the critical pressure. For ordinary practical use it is not possible to take advantage of the full theoretical thermal effect with toluene vapor as with steam; but for special purposes, where condensation could be effected at low temperatures (below 0 deg. C.), the utilization of thermal energy could be made to compare very favorably with results now obtained with steam. With these limitations, the field of utility of toluene vapor is confined to small installations, and these chiefly for special purposes.

DETECTING STRESSES IN METAL. R. Drahokoupil. *Zeitschrift des Vereines deutscher Ingenieure,* Oct. 11; p. 1422. X-ray photograms of iron and steel are being applied to the detection of internal stresses in the metal, with the aid of a new technique which eliminates the necessity of cutting a thin section of the metal for making the examination. Thus the method becomes applicable to many cases where cutting of a section for testing is not permissible. A film is placed over the spot to be examined, and the interference colors emitted by the metal at its surface are thus photographed. This method loses that half of the interference colors which could be photographed only by transmission through the body of the metal; but these colors would be approximately the same, and are not essential to the test. Confirmatory tests of the reliability of the method have been made by examination of specimens in which the internal stress could be estimated, in comparison with stress-free specimens of the same metal. Further confirmation was obtained by making X-ray photograms of a specimen of stress-free metal, then gradually applying known stresses and making frequent X-ray exposures by the new method. The photograms are made on a two-surfaced film, from which they are not readily reproducible. From the qualitative results so far obtained, it is expected that further refinements of the method will make it applicable to quantitative estimates of internal stresses.

PICKLING METAL. Heinz Bablik. *Korrosion und Metallschutz,* October, pp. 223-8. Evolution of hydrogen in pickling iron and steel is detrimental in more ways than the mere losses of metal and acid involved in the chemical action. There is a certain amount of diffusion of hydrogen into the metal, with harmful effects. The damage is particularly noticeable when the pickled metal is to be galvanized. The amount of diffusion of hydrogen into metal is governed mainly by the temperature, the surface concentration of hydrogen, and the nature of the metal surface.

Both the physical structure and the chemical composition of the metal are important factors. The kind of acid used in pickling also exerts an active influence on the amount of hydrogen evolved and on the amount of diffusion. Comparative measurements with sulphuric and hydrochloric acids show a rapid increase of hydrogen with rising temperature, the amount being generally about twice as great in sulphuric as in hydrochloric acid. This difference is further multiplied by the temperature relations, in that hydrochloric acid can be effectively used at a lower temperature than sulphuric acid. Hence any metal which is sensitive to acid attack in pickling baths should be pickled with hydrochloric and not with sulphuric acid.

Wood Tanks. W. Graulich. *Farben-Chemiker*, October; pp. 16-20. For heating the contents of wood tanks, low-pressure steam is practically equivalent to high-pressure steam, the only difference being that the higher heat content of high-pressure steam permits use of somewhat less total quantity. The important factor is quantity of steam, not its pressure. The time of heating a tank full of liquid will be the same with steam, say, at 2 atm. as with steam at 8 atm., if the quantity of steam is the same in each case. These considerations are simple and plain, but are too much neglected. To emphasize the factors involved in heating liquids in wood tanks with steam coils, a numerical comparison is made of two cases, one with steam at 2 atm. and one with steam at 8 atm. Careful distinction is made between the heat transmission coefficient between steam and boiling liquid and the coefficient between steam and liquid which is not boiling. The steam-coil calculations are based on the three aspects of heat transfer: (1) from steam to inner pipe wall; (2) through pipe wall; and (3) from outer pipe wall to liquid. The calculations show how increasing values of the heat transmission coefficients greatly decrease the size of steam coil required.

Testing Strength of Materials. Friedrich Schubert. *Kautschuk*, October; pp. 207-10. A new test machine has been devised in which a blunt rod is forced through the test piece under specified conditions. When the sample is properly shaped and clamped, a strictly local tear is the result of failure under load, and the resistance to this type of failure is so definite that different fabrics can be identified by this characteristic alone. The test is applicable to many kinds of materials; among the exceptions, in which failure is more complicated than a simple local tear, are low-grade celluloid and thin strips of wood foil. For textiles the test is superior to the familiar tearing test, especially in fabrics in which the weft is loose compared with the warp. The effect of chemical treatments on strength is readily revealed by this test; as examples, an over-bleached cotton showed a 50 per cent strength loss, a weighted silk 57 per cent loss, and wool mixed with artificial wool, 33 per cent loss. In general, it may be said that the new test gives a more precise and dependable basis for judging the quality of materials than is furnished by the older tests. It is easily and quickly carried out, requires only a small sample, and permits a ready comparison with results of other test methods. Photographs of the machine and of test pieces are shown.

Adsorption in Oil Refining. E. Bosshard and W. Wildi. *Helvetica Chimica Acta*, July; pp. 572-86. In decolorizing and desulphurizing petroleum and its distillates, the adsorbent has to remove both colloidal and crystalloidal impurities; the coloring matters are generally colloidal and the sulphur compounds are present in true solution. Comparative tests have been made with silica gel, fullers earth, floridin, kaolin, and several proprietary earth preparations, using a heavy oil to measure decolorizing effect, and a light distillate for the desulphurization tests. Measurements also were made of the heat of wetting of each adsorbent in 99 per cent alcohol, in an effort to correlate the decolorizing and desulphurizing efficiencies with the heat of wetting. It was observed that silica gel was superior to fullers earth for desulphurizing, but inferior for decolorizing. It was also found that the gel which was most effective in adsorbing colloids (decolorizing) was least effective for crystalloids (desulphurizing), and vice versa. In the fullers earths, heat of wetting is proportional to adsorption capacity, either for colloids or crystalloids. It is proportional, both in the earths and in silica gel, to the active surface, which increases as the pore size decreases. With respect to the homologous series of alkyl sulphides, the adsorptive capacity of silica gel decreases regularly from ethyl sulphide to amyl sulphide; so also do the heats of wetting with the pure sulphides. This confirms the Gurwitsch hypothesis, that heat of wetting is a measure of the physico-chemical attraction forces of the adsorptive. The pore size of silica gel naturally has much influence; one with coarse pores could be used to advantage for decolorizing a heavy oil, but was much inferior to a fine-pore gel for desulphurizing the same oil.

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Miscellaneous Publications

Mineral Resources of New Mexico. By E. H. Wells. New Mexico School of Mines, circular No. 1 (revised). Socorro, New Mexico, 1930. 15 pages.

Effect of Vacuum on Oil Wells, by Ben E. Lindsly and W. B. Berwald. Bureau of Mines Bulletin 322; 35 cents.

Aircraft Woods: Their Properties, Selection, and Characteristics, by L. J. Markwardt. National Advisory Committee for Aeronautics Report 354; 20 cents.

The Mineral Resources. By Gar A. Roush. From "Conservation of our Natural Resources," the MacMillan Company, New York. 95 pages. Section on minerals from Van Hise's revised edition.

Transportation by Rail of Explosives and Other Dangerous Articles by Freight, including Specifications for Shipping Containers. Agent, B. W. Dunn's Freight Tariff No. 2. Issued at 30 Vesey Street, New York, N. Y. 200 pages.—Interpretation of Interstate Commerce Commission regulations, effective this October, for more ready usefulness by those interested.

Fluorspar Deposits of Canada, by M. E. Wilson. Economic Geology Series No. 6 of the Geological Survey, Department of Mines, Canada. Available by purchase from that organization at Ottawa, Canada, at 20 cents a copy.—Includes not only details regarding Canadian deposits and their development but also general information of value to American producers and users of fluorspar.

Guide to the Sixth Achema Exhibition, Frankfurt. Published by Dechema, Seelze, Hanover, Germany. The more permanent part of this guide is an index to exhibitors of different chemical equipment.

American Gas Catalog and Handbook. Ninth edition, 1930. *American Gas Journal*, 53 Park Place, New York. In addition to the text, comprising various information on the industry, the 162 pages carry a large proportion of catalog advertising, so indexed as to be very useful to its field.

Transfer Coefficient of Ammonia in Absorption Towers. By O. L. Kowalke, O. A. Hougen, and K. M. Watson. University of Wisconsin, Engineering Experiment Station Bulletin No. 68, Madison, Wis. The date, 1925, appearing on this bulletin is misleading, since the work was not actually completed until recently.

The Maritime Provinces of Canada. Department of the Interior, Ottawa, Canada. 79 pages. A companion publication to the recent one on New Brunswick, with interesting and authoritative information on the past and potentialities of the territory in question.

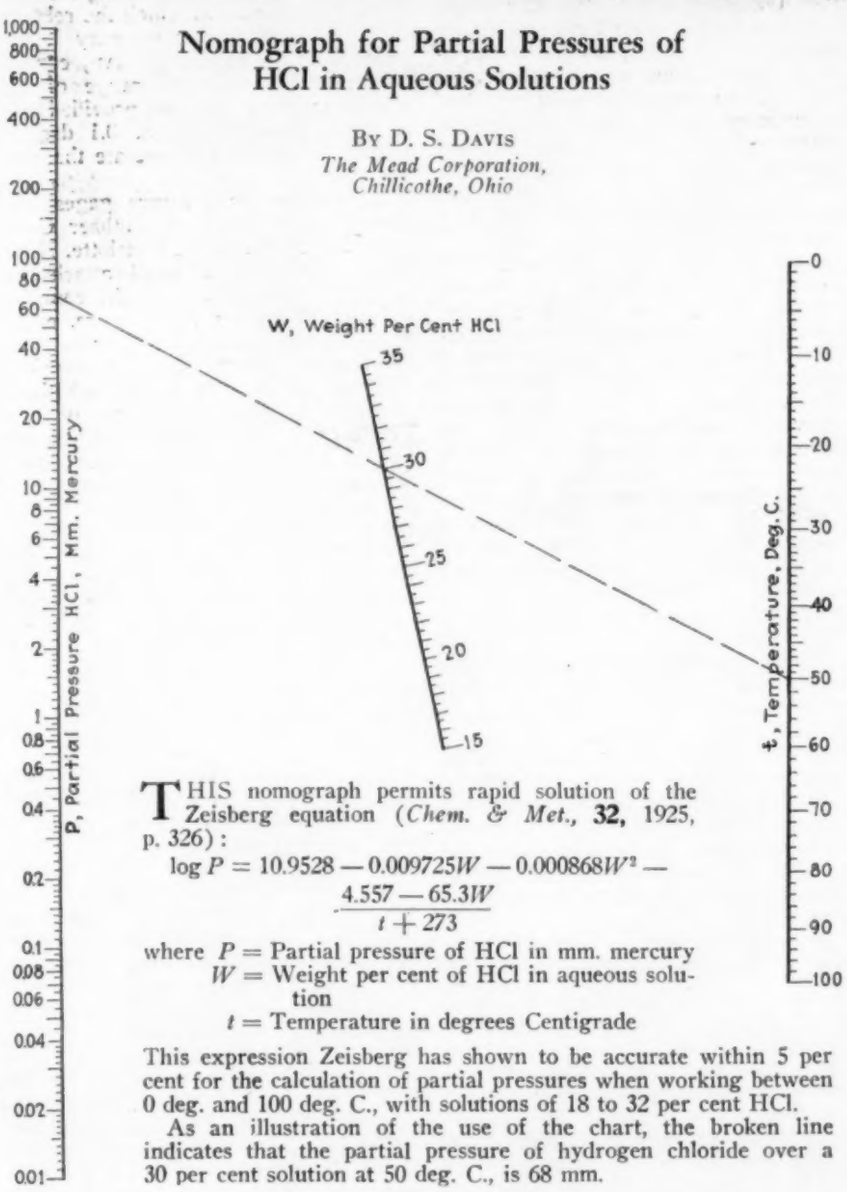
Research for Industry. Battelle Memorial Institute, Columbus, Ohio. 31 pages. Describes the scope of the research and facilities of this non-profit organization.

Bentonite. Bulletin No. 107, Silica Products Company, Kansas City, Mo. 22 pages. Illustrated description of properties, sources, geology, and production.

Simple Methods of Analyzing Plating Solutions. Hanson-Van Winkle-Munning Company, Matawan, N. J., 1930. 20 pages. Free on request. The rudiments formerly taught at the company's laboratories are here placed at wider disposal in printed form.

Nomograph for Partial Pressures of HCl in Aqueous Solutions

By D. S. Davis
The Mead Corporation, Chillicothe, Ohio



THIS nomograph permits rapid solution of the Zeisberg equation (*Chem. & Met.*, **32**, 1925, p. 326):

$$\log P = 10.9528 - 0.009725W - 0.000868W^2 - \frac{4.557 - 65.3W}{t + 273}$$

where P = Partial pressure of HCl in mm. mercury
W = Weight per cent of HCl in aqueous solution
t = Temperature in degrees Centigrade

This expression Zeisberg has shown to be accurate within 5 per cent for the calculation of partial pressures when working between 0 deg. and 100 deg. C., with solutions of 18 to 32 per cent HCl.

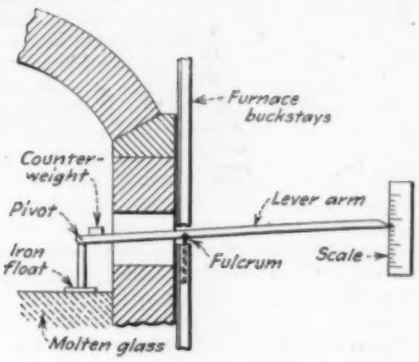
As an illustration of the use of the chart, the broken line indicates that the partial pressure of hydrogen chloride over a 30 per cent solution at 50 deg. C., is 68 mm.

Level Gage for Molten Glass

By F. W. Mowrey
Chemical Engineer, American Window Glass Company, Belle Vernon, Pa.

GLASS LEVEL in furnaces melting glass for the cylinder drawing process has ordinarily been obtained by dipping a heated iron rod, bent at right angles, into the glass and holding the rod level. As the temperature of the rod determines whether the glass will adhere or pull off, the accuracy of this method is not great. A variation of $\frac{1}{8}$ in. in level for the Fourcault drawing process is sufficient to cause serious trouble.

An apparatus shown in the sketch was designed to avoid the difficulties inherent in the earlier method of measurement. With this device it is possible to read the glass level within less than $\frac{1}{16}$ in. It consists of a lever arm capable of being supported on an adjustable fulcrum attached to the furnace buckstays. This is inserted whenever a reading is to be taken. Attached at the inner end of the arm is a 6x6x$\frac{1}{4}$-in. iron float, the leg of which is pivoted to the arm. A counterweight may be needed to hold the float down if the long arm is too heavy.



Easily Constructed Level Indicator for Glass

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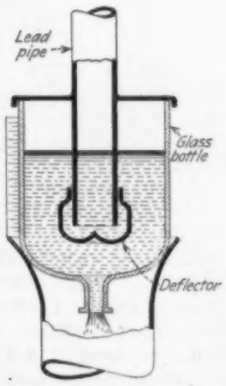
Meter for Acids

WHEN it is necessary to control the rate of flow of acids or other corrosive liquids within fairly narrow limits, the simple flow meter and indicator shown in the accompanying sketch will often prove satisfactory. As built for the control of sulphuric-acid flow in an Illinois plant, the meter consisted of an ordinary 1-gal. glass bottle from which the bottom was cut by the familiar method of wrapping with a kerosene-soaked string, burning the string, and dipping the bottle into cold water. A lead cover burned to the lead inlet pipe and a lead baffle or flow deflector completed the apparatus. Although a rough calibration may be made using the hydraulic flow formula, it is necessary to calibrate head against discharge rate by actual measurement where any degree of accuracy is desired.



A Glass Bottle From Which the Bottom Has Been Removed Makes an Effective Flow Meter for Corrosive Liquids; Head Corresponding to G.P.M. Flow Is Marked on the Scale

EQUIPMENT NEWS
FROM MAKER AND USER

Power Show Brings Out New Equipment

BUSINESS DEPRESSION appears to have been forgotten during the week of Dec. 1, when the Ninth Annual Exposition of Power and Mechanical Engineering was held in the Grand Central Palace in New York. Bearing out the belief we expressed editorially in our November issue, interest in the show ran high, every session was well attended, considerable new equipment was in evidence, and exhibitors expressed themselves well pleased with the results. On the other hand, although new showings of interest to chemical engineers were about 25 per cent more numerous than in 1929, they were not as numerous as the evidence of earlier expositions in other fields this year had led one to expect. This brings up the question of whether the Power Show would not do well to follow in the footsteps of the Chemical Exposition, meeting biennially instead of annually.

NEW DEVELOPMENTS in other fields were more in evidence than those with chemical engineering application. Of the new showings, some have already been described in *Chem. & Met.*, and several are to be described in detail in this issue. Of the others, some of the more significant developments will later be the subject of more lengthy description in subsequent issues of *Chem. & Met.*

A new ball-and-ring mill for pulverizing coal and similar friable materials, built by the Fuller-Lehigh Company; a portable weld tester for pulling test coupons in the shop or in the field, offered by the Oxweld Acetylene Company; and a self-vulcanizing rubber compound known as "Covult," made by the Hitchcock Company, and used for coating chutes and conveyors, were new showings which are described in the current issue.

Manufacturers of instruments of various kinds, as in 1929, probably were most active as a group in the showing of new developments. Bailey Meter Company, 1050 Ivanhoe Road, Cleveland, Ohio, demonstrated a new long-distance transmitter for pressure indications. This device is an ingenious adaptation of the Selsyn motor, wherein pressure on a piston determines the setting of the Selsyn. Whenever there is a change in pressure, a hydraulically operated pilot device assists in determining the new Selsyn setting. A second Selsyn motor is used at a distance in the indicating instrument to show the pressure at the transmitter.

The Ranarex mechanical CO_2 indicator and recorder, put out by the Permutit Company, 440 Fourth Ave., New York, has been improved and made more reliable. The principle of the instrument remains the same; that is, it compares the torque produced by rotating columns of two gases, indicating this comparison on a scale. The instrument is now available in a panel model, as well as a wall type, and makes use of a round chart. The previous model employed a strip chart.

Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa., showed a new smoke detector, suitable also for detecting and recording the concentration of dust in flues. Smoke or dust is bypassed through a special duct on one side of which is a lamp, and on the other side, a thermopile. Condensing lenses focus the light in its passage across the duct. The voltage generated by the thermopile depends upon the transmission of light, which in turn is determined by the amount of smoke or dust in the flue. The voltage is recorded as smoke or dust concentration on one of the company's standard strip chart recorders.

Brown Instrument Company, Philadelphia, Pa., has developed a new control pyrometer. This is of the type in which mercury contactors are substituted for the usual open contacts. This makes possible the breaking of currents as high as 30 amp. at the instrument contacts. In a modification of the standard instrument, extra contactors are provided for breaking currents up to 60 amp. without the use of an auxiliary relay.

THERMOMETERS of new types were shown by three concerns. Moto Meter Gauge & Equipment Company, Toledo, Ohio, has developed a new recording thermometer with bimetallic compensation for temperature changes at the instrument. The Liquidometer Corporation, Long Island City, N. Y., has adapted its standard level gage transmission to a distant-recording, liquid-filled thermometer. This is available in both recording and indicating models. The transmission is of the double hydraulic type and is said to compensate accurately for temperature variations along the line between the bulb and the instrument, for any distance within reason. A very delicate mercury thermo-regulator has been developed by Struthers-Dunn, Inc., 139 North Juniper St., Philadelphia, Pa. This consists of a glass bulb and capillary containing mercury, in which are two electric contacts. A relay connected to the contacts is used to operate any control circuit. By heating the bulb to the temperature at which the relay is to be actuated, excess mercury is expelled from the apparatus. Any control temperature within the range of the instrument may thus be provided for. A temperature change of 0.1 deg. is said to be sufficient to operate the control relay.

A snubber for pressure gages was shown by the Pressure Snubber Company, 311 East 5th St., Charlotte, N. C. This consists of a small attachment which is screwed between the connecting pipe and the pressure gage, effectively ironing out any large fluctuations in pressure. It consists of a traveling clearing pin to the top of which is attached a head containing orifices. Fluctuations in pressure move the pin up and down, causing the gage to show the mean of the fluctuating pressure.

New controls of the Mercoid type were shown by American Radiator Company, 40 West 40th St., New York. There were two improved forms of the company's Model 858 Mercoid switch, one for temperature and the other for pressure. The improvements consist mainly in better adjusting devices for the high and low operating limits. These controls make use of mercury contactors.

NEW POWER generating and transmitting equipment was well represented. General Electric Company, Schenectady, N. Y., exhibited a new small turbine particularly suitable for use in plants where process steam is required. The turbine features very small size and integral control devices. The same company has introduced a small synchronous motor of 30 or more horsepower, especially adapted to be built into other equipment.

Among transmission devices, Reeves Pulley Company and Lewellen Mfg. Company, both of Columbus, Ind., have introduced completely inclosed models of their standard variable speed transmissions. Link-Belt Company, 910 South Michigan Ave., Chicago, showed for the first time a production model of its P.I.V. infinitely variable speed transmission. Hill Clutch Machine & Foundry Company, Cleveland, Ohio, has acquired rights to manufacture the Pulvis clutch described in the July, 1929, issue of *Chem. & Met.* This is being manufactured under the name of the Hill-Pulvis clutch, and as shown by this company is substantially similar to the device described in *Chem. & Met.*

Watson-Flagg Machine Company, Paterson, N. J., exhibited its new

"Front Gear" motor, a planetary helical-geared reducer which is attached directly to a motor. Since the planetary gears are made of Micarta, the reducer is extremely silent. The machine is now available in ratios from 4-1 to 12-1, in sizes from ½ hp. to 15 hp. It is anticipated that this reducer will be available shortly through motor manufacturers as well from the maker.

Foote Bros. Gear & Machine Company, 111 North Canal St., Chicago, displayed a new vertical-drive, worm-gear reducer of leakproof construction. Instead of the usual packing around the vertical low-speed shaft, the new reducer makes use of a well extending considerably above the oil level, so that no packing is required to retain the lubricant. This device is to be available, it is understood, on any of the vertical type reducers made by this company. Another novel speed reducer was shown by Gears & Forgings, Inc., Cleveland, Ohio. In appearance, this reducer is similar to the standard herringbone type, with the exception that the two sides of the herringbone gear are of different pitch. This construction is said to eliminate vibration and permit very high speed. It is understood that the company plans to use gears of this type in both single- and double-reduction machines, for a wide range of ratios and sizes.

A number of new valves were in evidence. Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., has two new automatic final shut-off valves, intended chiefly for gas, in which the valve shuts upon failure of the current. In both valves the actuating motor holds the valve at the wide-open position as long as it is energized, the valve closing under spring pressure in event of power failure. Automatic Switch Company, 154 Grand St., New York, showed two new solenoid-operated valves. One is made in both three- and four-way models, adapted particularly for pilot control. The second, for 250-lb. maximum pressure, known as Model FH Heavy Duty, employs a solenoid to operate a pilot valve. The line pressure opens or closes the main valve by means of a piston directly connected to the valve disk. A third company showing a new solenoid valve was the Schwitzer-Cummins Company, Indianapolis, Ind. This is known as the Carraway "Packless" valve and is intended for remote and automatic control. This valve also is of the pilot-operated type in which the pilot is controlled by a solenoid.

NEW VALVES doing away with the ordinary slip stem were shown by H. Belfield Company, 435 North Broad St., Philadelphia. These valves make use of a rotating stem which actuates a crank to lift the fully or partially balanced disk.

Alsop Engineering Corporation, 89 West 60th St., New York, has developed a new water filter. This consists of a pressure casing containing a screen over which are wrapped two layers of filter paper. Any number of filters may be connected parallel to give sufficient capacity. These devices have 400 sq.in. of filtering area, ¾-in. pipe connections and a capacity of 15 gal. per minute at 25 lb. pressure. The casings are built for 100 lb. pressure.

Nathan Mfg. Company, 416 East 106th St., New York, has introduced a new spinning pump for rayon manufacture. This pump is of the three-plunger type, but differs from the conventional form in that there is no rotating cylinder. This construction is said to make it easy to keep the pump tight and accurate. Delivery according to the company, is uniform within 2 per cent throughout the stroke. The adjustment range of the pump is 15 per cent. Pistons are oscillated by a swash plate, as in most rayon pumps.

A significant development in the alloy steel field was shown by the Babcock & Wilcox Tube Company, Barberton, Ohio. This company has been working on the development of centrifugally cast Nirosta KA-2 pipe. It is anticipated that this development will make possible the production of larger pipe sizes in this metal than were heretofore available.

Another exhibit of much interest was a showing of a fusion welded boiler drum by Combustion Engineering Corporation, 200 Madison Ave., New York. Both this company and the Babcock & Wilcox Company have been active in recent months in this development, evidently anticipating early approval of fusion welded boiler drums by the A.S.M.E. Boiler Code Committee.

Heating and cooling equipment was well represented. Buffalo Forge Company, Buffalo, N. Y., showed a new design of unit heater known as Model B "Breezo-Fin." This is of the type in which air is circulated by a fan over many turns of extended surface tubing. The heater is suitable for steam pressure from 2 to 250 lb. De Bothezat Impeller Company, 1922 Park Ave., New York, exhibited a new unit heater of very unusual design. This is a large-capacity device in which a fan located at the bottom throws air upward through heating coils, the air later discharging at the top through multiple openings. The theory of this device is that more uniform heating may be secured by heating the upper layers of air in a room first, then forcing the heat down into the working area.

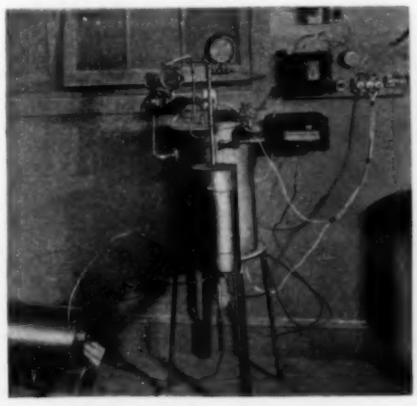
Two unit coolers were shown. One manufactured by Schwitzer-Cummins Company, Indianapolis, Ind., features an automatic defrosting arrangement. When frost on the coils decreases air flow through the cooler, an automatic switch shuts off the flow of refrigerant until defrosting has been accomplished, whereupon the refrigerant is again admitted to the cooler. Units are available only for temperatures above 32 deg. F. It is understood that they are later to be made for sub-freezing temperatures. The Grinnell Company, Providence, R. I., also showed a new unit cooler. This machine can be used with direct expansion ammonia, brine, or other refrigerants. It is said to replace more than ten times its weight in pipe coils. Automatic defrosting also is a feature of this cooler.

Cracked Ammonia Supplies N_2 and H_2

A CONVENIENT and economical means of producing hydrogen (or nitrogen) from cracked ammonia has been developed by the DuPont Ammonia Corporation, Wilmington, Del. This is described in detail elsewhere in this issue of *Chem. & Met.* The ammonia cracker, or dissociator, yields a gas containing 75 per cent hydrogen and 25 per cent nitrogen by volume. Since one cylinder, holding 100 lb. of ammonia, will produce a volume of hydrogen equivalent to 17 cylinders of the commercial product, at a unit cost of about half that in cylinders, this method obviously is economical.

When nitrogen is desired, the hydrogen may be burned out in a closed combustion chamber with the proper proportion of air to yield water and nitrogen. In this case one cylinder of ammonia is equivalent to 39 cylinders of nitrogen. The cost is about one-ninth the cost of commercial compressed nitrogen. The apparatus itself (covered by patents and patent applications) is simple, inexpensive, and easy to construct. This is evident from the accompanying illustration, which shows one of the experimental models built by the DuPont Ammonia Corporation.

Experimental Ammonia Dissociator



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Small Colloid Mill

MANUFACTURE and marketing of the "Disper-Mill," a laboratory colloid mill, has been announced by the Diamant Tool & Manufacturing Company, 401 Mulberry St., Newark, N. J. Although this is called a laboratory mill, the machine is large enough for small-scale plant production, being capable of making emulsions and dispersions at the rate of 20 to 60 gal. per hour.

The mill is of the type in which a conical rotor rotates with close clearance within a conical stator, the two parts being grooved to increase shearing effect. Monel metal is used for the

working surfaces. Clearance between rotor and stator is automatically regulated.

The feed bowl is of 2 qt. capacity and is arranged to agitate the material until it is fed over the dispersion surfaces. The outlet valve is so designed that material may be recirculated continuously if desired. The mill is equipped with ball bearings of special design with lubricant sealed in the housings. According to the manufacturer, bearings should not require attention oftener than once a year.

A special fan is used to cool the ¾-hp. universal motor at all times. Rotor speed without load is 14,000 r.p.m., and with average load, 9,000 to 10,000 r.p.m. Total weight of the machine is 38 lb.

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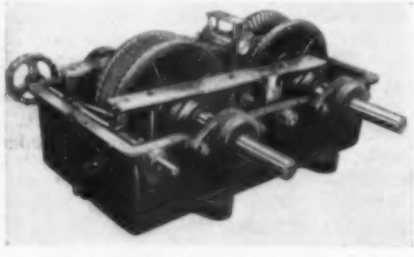
Variable Speed Transmission

ORIGINALLY developed in England and described in the March, 1927, issue of *Chem. & Met.*, the P.I.V. (Positive Infinitely Variable) Gear is now being manufactured by the Link-Belt Company, 910 South Michigan Ave., Chicago, Ill.

In appearance this device is somewhat similar to other variable speed transmissions employing adjustable conical disks and belts with side friction contacts. It differs, however, in that the transmission element is a steel belt, carrying self-adjustable teeth which project beyond the sides of the chain and positively engage radial teeth cut in the disks. These radial teeth are clearly shown in the accompanying illustration. The adjustable teeth consist of numerous hardened steel laminations or slats which extend through the links at right angles to the direction of motion of the chain.

Self-pitching of the chain to any tooth width or wheel diameter is assured by



P.I.V. Gear With Cover Removed to Show Mechanism

this construction. At each engagement of the chain and wheels, the laminations are regrouped within their separate containers, but do not slide or move under working pull. Their movement in engaging with the wheels is complete before the load is applied. When it is desired to change the speed ratio of the transmission, the distances separating the two pairs of disks are altered by means of the handwheel. The distance one pair of disks is moved apart is equal to the distance the other pair is moved together. Thus the effective driving diameters are varied and the new ratio established.

All elements of the new gear are built into and protected by a compact oil-tight housing and are automatically lubricated by splash. A speed indicator permits ready check-up on operating speed settings. The gear is obtainable in five sizes, from 1 to 10 hp. capacity, providing speed change ratios up to a maximum of 6 to 1.

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Simplified Belt Carrier

ROLLER BEARINGS are used in the new "Pacific type" belt conveyor carrier which has recently been announced by the Stephens-Adamson Mfg. Company, Aurora, Ill. The carrier is of the three-roller, 20-deg.-troughing design. With the exception of the two end-stand castings, construction is entirely of heavy-gage pressed steel. This is said to make the carrier light, strong, rigid, and practically unbreakable. The carrier is equipped for pressure lubrication and is built for conveyor belts from 18 to 48 in. in width.

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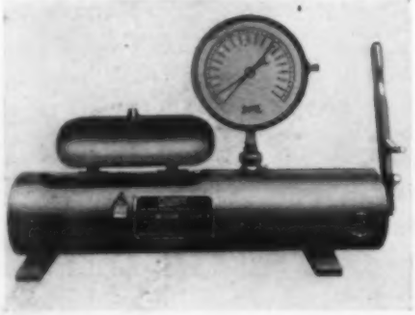
Portable Weld Tester

TENSILE STRENGTH determinations on samples of welded metals may be made immediately in the field or shop by means of a new portable tensile testing machine announced by the Oxweld Acetylene Company, 30 East 42d St., New York. This machine weighs 165 lb., measures 28 in. in overall length, and 6¼ in. in maximum diameter. It is self-contained, totally inclosed, and when prepared for shipping, presents a substantially smooth cylindrical surface.

When the machine is set up for use, it is necessary to attach a pressure gage and a pump handle. The mechanism consists of a tubular compression member with a set of grips in the head and a hydraulic cylinder block in the base. The cylinder block contains a communicating pump and cylinder directly machined into a single block, and the cylinder pressure operates a piston carrying a second set of grips. The specimen to be tested is placed between the grips, the release valve is closed, and the pump handle is moved back and forth. The load at rupture is indicated on the gage dial directly in pounds per square inch. By means of a set of conical blocks, the machine may be used also in pulling standard 2-in. diameter round specimens.

Portable Weld Tester Ready for Use



This company has also announced a new two-stage oxygen regulator which uses two separate and independent sets of diaphragms, valves, and springs, and is said to guarantee freedom from fluctuation of oxygen pressure. In the first stage of reduction, the cylinder pressure is reduced to less than 250 lb. This pressure is non-adjustable. The oxygen then passes to a second stage from which it emerges at any working pressure desired by the operator.

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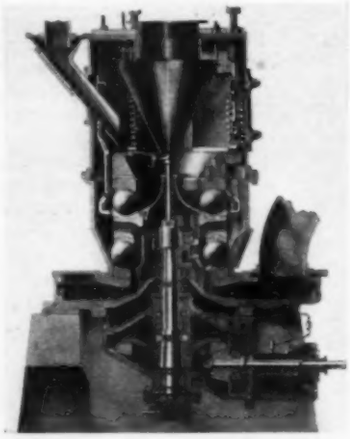
Air-Separation Pulverizer

AN ACCOMPANYING illustration shows a cross-sectional view of the new Type B pulverizer developed by the Fuller Lehigh Company, Fullerton, Pa., for coal grinding. The principle of the machine is that of the older Lehigh mill: namely, the use of a number of balls rotating in contact with grinding rings.

Construction of the mill is evident from the illustration. Coal fed to the spout at the upper left is thrown by the rotating feed cone between the balls of the upper grinding stage. The two rows of balls rotate between stationary rings at the top and bottom, and a rotating intermediate ring. Material which is



Fuller Lehigh Type B Pulverizer

ground by the first row of balls and passes outward and downward through the annular space between the intermediate ring and a perforated "coal basket," falls between the balls of the lower row, where it is reground.

At the same time, air is brought into the duct at the right, passes up inside the lower row of balls, out between the balls, and through cored openings in the intermediate ring, then travels upward to the top of the mill, down into a classification cone, and finally up the center tube and out of the mill. After the material reaches the proper reduction, it is picked up by the air stream and removed from the mill, as indicated. Oversize material is thrown out of the air stream at each of the several bends and returns to the grinding balls. Oversize not previously ejected is removed in the classification cone and returned to both pulverizing stages.

Among the special features of the mill is provision for adjusting the grinding pressure through springs controlled from the outside. Another feature of importance is the absence of lubricated parts in the grinding zone. Lubrication is required only in the lower or drive portion of the machine, which is carefully sealed to prevent the entrance of dust. Since the mill avoids metal-to-metal abrasion, wear is said to be slight and maintenance low. Power consumption, according to the manufacturer, is proportional to the coal fed and is inconsiderable.

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Gas-Engine-Driven Welder

RATING of 400 amp. is given to a new gas-engine-driven welder which has been put on the market by the Lincoln Electric Company, Cleveland, Ohio. As appears from the accompanying illustration, the welder is of the

400-Amp. Portable Gas-Engine-Driven Arc Welder

portable type, used principally for field work. Its current range is up to 500 amp., and its operating speed 1,500 r.p.m. It is of the single-operator, variable-voltage type with unified control. The motor is of six cylinders with developed horsepower of 55 at 1,500 r.p.m. Weight of the complete machine is approximately 3,500 lb.

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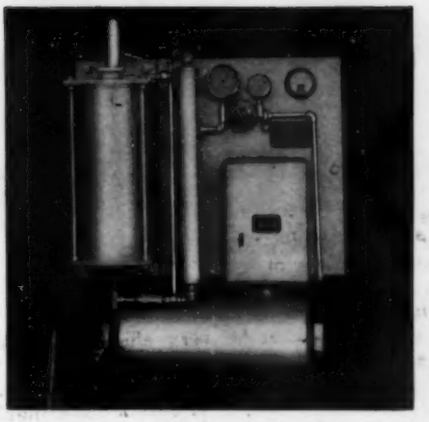
Electric Ammonia Dissociator

GENERAL Electric Company, Schenectady, N. Y., has recently announced equipment for the dissociation of anhydrous ammonia into its component nitrogen and hydrogen. The machine is intended primarily for producing hydrogen for atomic hydrogen welding. It is capable of supplying enough dissociated hydrogen to operate a ⅛-in. electrode holder at current values up to and including 70 amp. The pressure of the gas at delivery does not exceed 10 lb. per square inch. The electrical rating is 3.5 kw. at 220 volts, 60 cycles, a.c.

The apparatus, which is supplied from a standard cylinder of anhydrous ammonia, consists of a heat exchanger, an electrically heated catalyst, and the necessary temperature control and indicating devices, regulator, safety devices, etc. It is set in operation by a small snap switch, and after about 10 minutes, the temperature indicator will show a reading within the operating



Ammonia Dissociator Intended Principally for Atomic Hydrogen Welding

zone. The ammonia tank valve is then opened and the operator is ready to weld. As soon as the arc is struck, the gas will flow, and when the arc is broken, the gas will stop. During welding, the dissociator needs no attention. It is not necessary for the operator to start using gas as soon as the operating temperature is reached, nor is it necessary to shut off the gas, even though the operator should cease welding for some time.

❖

Self-Vulcanizing Rubber Compound

RESURFACING conveyor belts and lining chutes, hoppers, agitators, and other equipment is possible with a new rubber compound known as "Covule," made by The Hitchcock Company, 48 Pearl St., Boston, Mass. This is a soft, plastic rubber compound made in various colors, which is applied to a surface in the form of a paste and rapidly vulcanizes itself when exposed to the air. After vulcanizing, it is said to remain soft and flexible during its life.

The material is available also in the form of sheets already vulcanized to a fabric or wire-mesh base. In this form, it may be cut to any size desired for lining chutes and hoppers. Either form is easily applied, according to the manufacturer. For example, in repairing a conveyor belt, the cleaned belt is brushed with a special cleaning fluid, coated with a rubber solution, after which the plastic rubber is applied with a spatula or putty knife and smoothed with a glass roller. The material is reported to vulcanize sufficiently in about three hours, and under hot and dry conditions in even less time.

❖

Metallic Packing Material

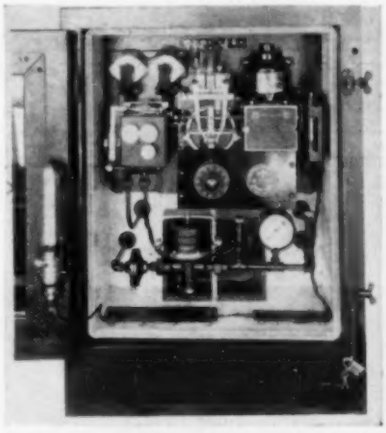
METAL PARTICLES, asbestos fiber, binder, and a specially prepared lubricant, incased in a thin shell of cellulose film, constitute a new form of packing recently placed on the market under the name of "Cordex" by Metalastic, Inc., Union City, N. J. The packing comes in straight rods, 18 in. in length. It is wrapped around the piston rod, and when the stuffing box and gland are drawn up, the casing disrupts and permits the packing to fill the stuffing box completely. This packing is said to combine the advantages of the loose forms of semi-metallic packing with the advantage of easy insertion into the stuffing box. It is available in all sizes from ⅛ in. to 1 in. in diameter and 18 in. long. Two grades, for 500 deg. and for 1,200 deg. F., are available.

❖

Potentiometer Pyrometer Controller

ANNOUNCEMENT is made by the M. W. Kellogg Company, 225 Broadway, New York, of the new de Florez temperature controller for automatic firing of oil stills. This instrument combines a Leeds & Northrup potentiometer pyrometer controller with an air-pilot-operated, balanced diaphragm valve. The controller is guaranteed to give an accuracy of oil outlet temperature control within ± 2 deg. F.

The temperature-sensitive device is a thermocouple, which is connected to a self-balancing potentiometer of the usual Leeds & Northrup type. Depending on whether the temperature is above or below the control point, the balancing mechanism energizes either a high or low relay several times per minute. If the temperature be high, the high relay functions to close the balanced diaphragm valve slightly for a period of time dependent upon the magnitude



De Florez Temperature Controller Showing Principal Mechanism Other Than Balanced Valve

of the deviation. The reverse is true if the temperature be low. If the deviation be unimportant, there will be no change made in the valve.

Therefore, after any temperature change, corrections are made to the valve periodically, the valve returning between corrections to its normal point. Meanwhile, during a certain period of time, an integrating device sums up the corrections in both directions, and at the end of the period of time, if the preponderance of corrections is in one direction, makes a permanent change in the valve setting which more closely approximates the new conditions.

By this method it is claimed that

hunting is eliminated, as well as overshooting of the control point. Among the advantages of the instrument, the manufacturers point to the design of the special balanced fuel valve which contains no stuffing box, and is consequently rapid and accurate in its action.

❖

Non-Indicating Controller

TWO NEW contact-making temperature controllers of the non-indicating type have been developed by Harold E. Trent Company, 439 North 12th St., Philadelphia, Pa. Type NI-5 is intended for temperatures from 100 to 500 deg. F., and Type NI-10, for 200 to 1,000 deg. F. As indicated in the illustration, these controllers are graduated in arbitrary divisions rather than in temperature. The temperature system consists of a mercury bulb connected to a bourdon spring which, as it moves, serves to close high or low contacts. Using a suitable relay, the manufacturer claims an accuracy of ± 5 deg. with this controller.

New Non-Indicating Temperature Controller

This company also has developed protecting tubes for the control bulbs, made in three standard lengths of copper, steel, or Monel metal. The tubes are threaded for screwing into the apparatus, and the bulb may be secured in the tube through use of a special split bolt which is said to simplify installation and reduce the number of pieces that must be handled.

❖

Asphalt-Aluminum Coating

ASPHALT dispersed in a volatile solvent, plus flake aluminum, constitutes a new asphalt-base paint recently put on the market by Headley Emulsified Products Company, Franklin Trust Building, Philadelphia, Pa. The flake aluminum is prepared by stamping, after which it is polished. A thin film of solvent-repelling polishing agent, which remains on the aluminum flakes, causes them to work their way to the outer surface of the applied coating before the asphalt begins to harden. The finish is, therefore, bright and highly reflecting, having at the same time great covering power and long life, according to the manufacturers.

It is claimed that one coat of this material ordinarily will suffice, regardless of the previous color of the wood, metal, or other material to which the paint is applied. The material is also said to be very efficient as a priming coat for other paints. It is recommended for both interior and exterior work and is said to be particularly effective in reducing evaporation from metal tanks, due to its reflectivity. Its resistance against corrosive atmospheres is said to be excellent.

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Corrosion Resistant Paint

FOR RESISTANCE to mineral and organic acids, mild alkalis, alcohol, benzol, gasolene, acetylene, oils, greases, soaps, steam, sunlight, and very high temperatures, Alfred Hague & Company, 130 West 42d Street, New York, is marketing a newly developed coating under the name of "Rubalt G." This coating forms a very hard cement-like surface with a rough gray finish, for use on metallic or other surfaces. It is adhesive but not elastic. It is air drying. In being applied, it is maintained at the proper thickness by adding a small quantity of water. It is flowed on thickly in two coats, and after the second coat is dry, a coat of hardening compound is applied. In two days more, the coating is ready for service.

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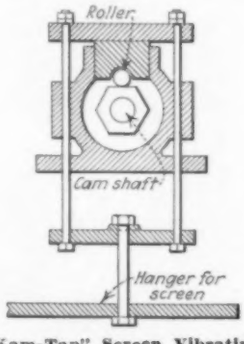
Cam-Operated Screen

SCREENING of all kinds of material, fine or coarse, wet or dry, is said to be possible with the new "Kam-Tap" vibrating screen, developed by the Williams Patent Crusher & Pulverizer Company, St. Louis, Mo.

A sketch reproduced here illustrates the vibrating mechanism used. This consists of a cam with from four to eight points which operates in an oil bath in contact with a cam roller. The screen is supported from the cam roller near its upper end, and supported by means of a spring suspension at its lower end. By varying the number of cam points and the speed of cam rotation, the vibration of the screen may be adjusted within wide limits, for any desired type of operation.



"Kam-Tap" Screen Vibrating Mechanism

This screen is built in ten sizes with one, two or three decks. A light type is available for handling light, finely ground materials in sizes from 8 to 200 mesh; and a heavy-duty type for screening rock, shale, coal, and similar heavy materials. Both types are intended to handle either wet or dry materials, and operate either from a belt or from an individual motor drive mounted on the screen frame.

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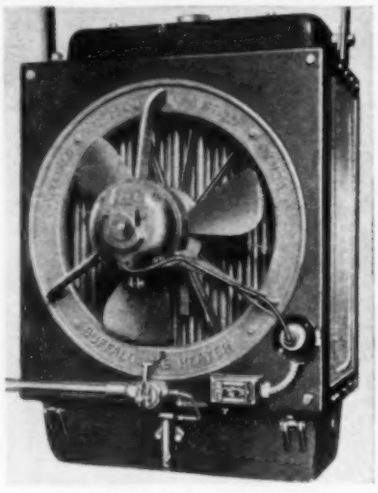
Gas Unit Heater

INDUSTRIAL HEATING may be accomplished with a new gas-burning unit heater recently announced by Buffalo Forge Company, Buffalo, N. Y. The accompanying illustration shows the heater to consist of a large number of vertical brass tubes through which the products of combustion pass from a number of burners. Air is forced between the heated tubes by means of a motor-driven fan. Air delivery is at the rate of 2,300 cu.ft. per minute. Safety features include devices which shut off the gas and motor if the pilot blows out, if the current is interrupted, or if the burner pan is opened for inspection. Advantages of the heater include a low initial cost, elimination of boiler and accessories, cleanliness, low labor expense, and light and compact design.



New Gas-Fired Unit Heater

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Portable Light

ALTHOUGH developed primarily for use in mines, the "Stringalite" safety lighting cable, recently announced by Sullivan Machinery Company, 400 North Michigan Ave., Chicago, is said to be equally useful for other industrial applications, both indoors and outdoors. The cable is provided in two standard lengths, 100 and 200 ft., and consists of a heavy rubber-covered two-conductor light cable to which are attached at 33⅓-ft. intervals molded-rubber-covered porcelain lamp sockets. One end of each length is provided with a molded-rubber-covered plug, and the other with a molded-rubber-covered plug socket, so that any number of lengths may be connected together. Special two- and three-way plug sockets are available for connecting branch lines.

Tractor-Operated Equipment

TWO NEW pieces of tractor-operated equipment, a power shovel and a crane, have been announced by the Clark Tructractor Company, Battle Creek, Mich. The shovel is shown in the accompanying illustration. It is designed for handling any loose material such as sand, gravel, fertilizer, bulk cement, clay or soft coal, and is said to do the work of 10 to 15 shovel and barrow men. The bucket holds 9 cu.ft., or 1,500 lb. A hydraulic lifting device enables the driver to pick up and hold the load at any desired point. The tractor is gasoline driven and includes

Power Shovel for Handling Fertilizer and Similar Materials

as standard equipment a starter, generator, battery and head and tail lights. Fuel consumption is said to be 5-6 gal. of gasoline per day.

The second piece of equipment, the crane, also is mounted on a tractor. It has capacity to lift 2,000 lb. to a height of 13 ft. With the boom horizontal, the entire equipment has an over-all height of 7 ft. 10 in. This is said to permit easy operation of the crane in the average factory. The power plant is similar to that described in connection with the power shovel.

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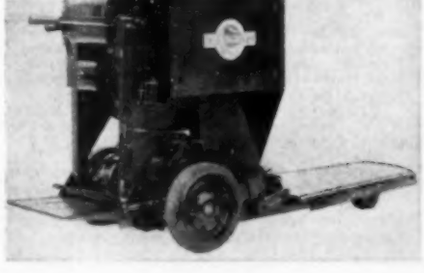
Power Lift Truck

TO FIT into the field between larger, heavier industrial trucks and the ordinary hand lift truck, Crescent Truck Company, Lebanon, Pa., has introduced a new power lift truck for use with hand-truck platform skids of 7 in. or more height. The capacity of the truck is 3,500 lb., its turning radius is 7 ft., and it is provided with two speeds forward and two speeds in reverse. Special features include a cantilever spring suspension on the driving unit, rubber tires on all four wheels, and a 3½-in. lift. Exclusive of the operator's wages, the manufacturers state that the operation cost is less than 18 cents per hour, including all fixed charges.

Power Lift Truck for Hand-Truck Skid Platforms



Manufacturers' Latest Publications

Apparatus. The Palo Co., 153 West 23d St., New York—Folder describing various pieces of laboratory apparatus supplied by this company. Also leaflet giving special sale prices on certain classes of apparatus.

Chemicals. Niacet Chemical Corp., Pine Ave. & 47th St., Niagara Falls, N. Y.—Third edition of "Niacet Products," a booklet giving the specifications, properties, uses, and other information concerning the products made by this company.

Chemicals. Synfleur Scientific Laboratories, Inc., Monticello, N. Y.—Fall, 1930, catalog and price list of synthetic specialties, organic products, colors, and other cosmetic and perfume materials made by this company.

Colloid Mill. Diamant Tool & Mfg. Co., 401 Mulberry St., Newark, N. J.—Folder describing the Disper-Mill, a new small portable Travis colloid mill for light socket operation; capacity up to 40 gal. per hour.

Disintegration. J. H. Day Co., Cincinnati, Ohio.—12-page booklet describing three and five-roller grinding mills.

Disintegration. Fuller Lehigh Co., Fullerton, Pa.—Bulletin 5-80—4-page description of the new Model B pulverizer for coal made by this company.

Drying. Despatch Oven Co., 622 Ninth St., S.E., Minneapolis, Minn.—Bulletin 12—4 pages describing and illustrating special and intermittent conveyor ovens made by this company.

Economic Reports. Policyholders' Service Bureau, Metropolitan Life Insurance Co., 1 Madison Ave., New York—Index of economic reports prepared by this company, listing over 400 titles and revised as of Oct. 1.

Electrical Equipment. General Electric Co., Schenectady, N. Y.—Publications as follows: GEA-140A, hand starting compensators; GEA-372A, explosion chambers; GEA-579B, automatic full-voltage controllers; GEA-721, indoor bus supports; GEA-727B, hesitating control relays; GEA-841A, magnetic switch; GEA-959B, oil circuit breakers; GEA-1031B, resistor arc welders; GEA-1193A, automatic switchgear; GEA-1326, totally inclosed fan-cooled induction motors.

Electrical Equipment. National Electric Manufacturers Association, 420 Lexington Ave., New York—A handbook on motors and generators, 132 pages long, and available at $1.50 a copy.

Equipment. Consolidated Products Co., 11 Park Row, New York—Bulletin 11—Lists used machinery for crushing, pulverizing, filtering and drying.

Equipment. Traylor Engineering & Mfg. Co., Allentown, Pa.—Bulletin No. 4000, superseding 3,000, contains 104 pages of complete illustrated description of the company's products, especially crushing and grinding machinery.

Equipment. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—New general catalog for 1931-2 comprising 1352 pages with descriptions and illustrations representative of all the products of the company; an "instant index" is a new feature.

Flooring. Irving Iron Works Co., 3rd & Creek Sts., Long Island City, N. Y.—Folder with prices and engineering data on steel flooring, stair treads and floor armoring.

Glass-Blowing. Eastman Teaching Films, Inc., Rochester, N. Y.—Folder describing a new film on 16 mm. safety stock, showing glass-blowing technique. This film is in two parts, equivalent in all to 1,000 ft. of standard 35-mm. film.

Heat Generation. Hevi-Duty Electric Co., Milwaukee, Wis.—Bulletins 930, 1030, and leaflet on pot type furnace, vertical pressure carburizing furnace and automatic temperature cutout.

Heating. Buffalo Forge Co., Buffalo, N. Y.—Catalog 469—Describes, with information on choice and installation, five types of unit heater made by this company. Includes models for floor and ceiling installation, humidifying models, small suspended steam heaters, and gas-fired heaters.

Heating. Niagara Blower Co., 673 Ontario St., Buffalo, N. Y.—Bulletin 11—Describes a disk fan unit heater of the suspended type made by this company.

Heating. Harold E. Trent Co., 439 North 12th St., Philadelphia, Pa.—Leaflet TA-29—4-page folder on electric heating elements and units for element temperatures to 1,900 deg. F.

Instruments. Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio.—Bulletin 37—52-page bulletin describing several types of mechanically operated fluid meter for measuring flow of gases, vapors, and liquids.

Instruments. The Bristol Co., Waterbury, Conn.—Catalog 2002—20 pages on motor-operated valves for automatic control, also briefly describing certain of the control instruments made by this company.

Instruments. Brown Instrument Co., Philadelphia, Pa.—Catalog 46—16 pages on electric indicating and recording tachometers; also a display folder describing the CO_2 meter made by this company.

Instruments. The Esterline-Angus Co., Indianapolis, Ind.—Bulletin 1030—"Plugging Leaks in Production," reprint of an article on the use of recording instruments in discovering plant losses.

Instruments. The Hays Corp., Michigan City, Ind.—Catalog RA-31—24 pages on automatic combustion recorders for carbon dioxide, furnace draft and flue gas temperature.

Insulation. Armstrong Cork Co., Lancaster, Pa.—Publications as follows: Acoustical correction; erecting cork board insulation; nonpareil insulating brick; high-temperature insulation for industrial furnaces; insulation of roofs to prevent condensation; insulation of cold storage rooms; cork machinery insulation.

Lead Linings. United Drydocks, Inc., 11 Broadway, New York—Leaflets 32 and 33 briefly describe homogeneously bonded lead linings for high pressure, high temperature and high vacuum service.

Materials. Armstrong Cork Co., Lancaster, Pa.—Booklet on industrial applications of cork.

Power Transmission. Foote Bros. Gear & Machine Co., 111 North Canal St., Chicago, Ill.—Catalog 102—46 pages with specifications and data on herringbone and helical speed reducers made by this company under the name of "Titan."

Power Transmission. W. A. Jones Foundry & Machine Co., 4401 West Roosevelt Road, Chicago, Ill.—Catalog 48—40-page book describing herringbone gears, with horsepower and price tables.

Power Transmission. The Link-Belt Co., 910 South Michigan Ave., Chicago, Ill.—Book No. 1274—16-page booklet describing the P.I.V. Gear, a variable speed transmission made by this company.

Pumps. Allis-Chalmers Manufacturing Co., Milwaukee, Wis.—Bulletin 1647—16-page booklet describes type SSU centrifugal pumping units, consisting of a pump integral with the motor case; includes performance curves.

Pumps. Chicago Pump Co., 2336 Wolfram St., Chicago, Ill.—Bulletin 126—24 pages on non-clogging centrifugal pumps intended particularly for sewage disposal plants.

Refrigeration. United Cork Cos., Lyndhurst, N. J.—1931 edition of this company's handbook on insulation. Contains technical data, construction methods, insulation details, blueprint specifications, and the manufacturer's catalog data.

Resins. The Bakelite Corp., 247 Park Ave., New York—32-page booklet dealing with three varieties of Bakelite synthetic resins which are adapted for use in varnishes, enamels, paints and lacquers. Gives complete information on these applications.

St. Louis. Industrial Club of St. Louis, 511 Locust St., St. Louis, Mo.—"Chemical and Mineral Resources of the St. Louis Industrial District," 34-page brochure listing principal producers of chemicals in the St. Louis industrial district, listing principal chemical products produced in the district and describing the mineral resources of adjacent regions.

Silica Gel. The Silica Gel Corp., Baltimore Trust Building, Baltimore, Md.—"The Story of Silica Gel," giving in 50 pages a non-technical discussion of Silica Gel and its use in dehydration, air conditioning, refrigeration, refining, solvent recovery, catalysis, and other uses.

Welding. Fusion Welding Corp., 103d St. & Torrence Ave., Chicago, Ill.—12 page catalog of accessories for arc welding.

PATENTS ISSUED

Nov. 4 to Nov. 25, 1930

Pulp, Paper and Plastics

Process of Esterifying Cellulose. Franz Becker, Heinrich Heimann, and Alfons Bayerl, Dessau, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-Main, Germany.—1,780,151.

Aldehyde Amine Condensation Product. Ira Williams and Waldo Briggs Burnett, Pittsburgh, Pa., assignors, by mesne assignments, to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,780,326.

Substituted Guanidine-Aldehyde Condensation Product. Charles M. Stine, Wilmington, Del., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,780,636.

Production of Sulphite Pulp. George A. Richter, Berlin, N. H., assignor to Brown Company, Berlin, N. H.—1,780,842.

Paper-Pulp Beater. Walter N. Sherwood, North Hoosick, N. Y.—1,780,845.

Solution of Cellulose Derivatives. Angelo Knorr, Berlin, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfort, Germany.—1,780,883.

Fiber Liberating and Bleaching Process. George A. Richter and Milton O. Schur, Berlin, N. H., assignors to Brown Company, Berlin, N. H.—1,780,943.

Digestion of Fibrous Material. Thomas Leonidas Dunbar, Watertown, N. Y.—1,781,447.

Method for Manufacturing High-Grade Alpha Cellulose. Lauri I. L. Durchman, Petersburg, Va.—1,781,449.

Wood-Pulp Material. Joseph H. Wallace, Stamford, Conn., assignor to Pine Waste Products, Inc., New York, N. Y.—1,781,712.

Cyclic Process of Fiber Liberation. George A. Richter, Berlin, N. H., assignor to Brown Company, Berlin, N. H.—1,781,733.

Apparatus for the Manufacture of Artificial Silk. Henri François Niogret, Lyon, France, assignor, by mesne assignments, to Du Pont Rayon Company, New York, N. Y.—1,782,581.

Sulphur and Resin Compound. Stuart P. Miller, Philadelphia, Pa., assignor to the Barrett Company.—1,782,693.

Method of Treating Bagasse for the Manufacture of Wall Board and the Like. William L. S. Williams, Hilo, Territory of Hawaii, assignor to Hawaiian Cane Products, Limited, Hilo, Hawaii—1,782,755.

Method for Recovering the Fibrous Material from Sugar Cane. Joaquin Julio de la Roza, Sr., Brooklyn, N. Y., assignor to Bagasse Products Corporation, New York, N. Y.—1,782,869.

Petroleum processing and Products

Treating Hydrocarbon Oils. Claude W. Watson, Port Arthur, Texas, assignor to the Texas Company, New York, N. Y.—1,780,286.

Process for Breaking Petroleum Emulsions. Melvin De Groote, St. Louis, and Louis T. Monson, Maplewood, Mo., assignors to Wm. S. Barnickel & Company, Webster Groves, Mo.—1,780,343-5.

Process and Apparatus for Treating Hydrocarbons, Eugène Albert Prudhomme, Neuilly-sur-Seine, France, assignor to S. I. P. P., Paris, France.—1,780,536.

Process for Cracking Petroleum Oil. Robert T. Pollock, New York, N. Y., assignor to Universal Oil Products Company, Chicago, Ill.—1,781,128.

Art of Refining Hydrocarbons. Eugene C. Herthel, Chicago, Ill., assignor to Sinclair Refining Company, New York, N. Y.—1,781,388.

Apparatus for Fractionally Extracting Petroleum Hydrocarbons with Alcohol. Theodore A. Werkenthin, Lima, Ohio, assignor to the Solar Refining Company, Lima, Ohio.—1,781,420-1.

Process of Manufacturing Color Lakes from Petroleum. Gellert Alleman, Swarthmore, Pa., assignor to Sun Oil Company, Philadelphia, Pa.—1,781,772.

Art of Cracking Hydrocarbons. Horace K. Rogers, Chicago, Ill., assignor to Sinclair Refining Company, New York, N. Y.—1,781,884.

Art of Cracking Hydrocarbons. John E. Bell, Brooklyn, and Edward W. Isom, Locust Valley, N. Y., assignors to Sinclair Refining Company, Chicago, Ill.—1,782,056.

Process for Dewaxing Hydrocarbon Oils. Arthur R. Greig, Fort Arthur, Texas, assignor to The Texas Company, New York, N. Y.—1,782,467.

Method of Cracking and Processing Petroleum Hydrocarbons. John C. Black, Wilmington, Calif., assignor to Gasoline Products Company, Inc., Wilmington, Del.—1,782,676.

Process for Cracking Hydrocarbon Oil. Joseph G. Hawthorne, Kansas City, Mo., assignor to Walter Martin Cross.—1,782,686.

Process and Apparatus for Treating Oil. Jean Delattre-Seguy, Chicago, Ill., assignor to Universal Oil Products Company, Chicago, Ill.—1,782,809-11.

Method and Apparatus for Cracking Hydrocarbon Oils. Richard J. Dearborn, Summit, N. J., assignor to the Texas Company, New York, N. Y.—1,783,010.

Coal and Organic Products

Manufacture of High-Purity Carbon. Daniel Gardner, Ruell, France.—1,780,154.

Process for the Evolution of Hydrocyanic Acid. Hans Lehrecke, Frankfort, Germany, assignor to the Roessler & Hasslacher Chemical Company, New York, N. Y.—1,780,196-8.

Water-Soluble Product Derived from the Fatty Acids Occurring in Wool Fat and Process of Preparing the Same. Alfred Thauss, Deutz, and Gustav Mauthe, Holweide, Germany, assignors to General Aniline Works, Inc., New York, N. Y.—1,780,252.

Copies of Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Photostatic copies of foreign patents may be obtained at the same address, prices being forwarded on application.

Oxidation of Fats, Waxes, and Resins. Wilhelm Pungs, Ludwigshafen, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfort, Germany.—1,780,632-4.

Treatment of Carbonaceous Materials. Rudolf Lessing, London, England.—1,780,830.

Process of Preparing Ethyl Esters. Arthur R. Cade, Pittsburgh, Pa., assignor to Carbide & Carbon Chemicals Corporation.—1,781,050.

Method and Apparatus for Processing Materials by Means of Gases. Ben Forrest Uhl, Richmond Hill, New York, N. Y., assignor to Industrial Spray-Drying Corporation, New York, N. Y.—1,782,054.

Process for the Purification of Triaryl Phosphates. Wilfrid Gibson and Charles Royston Henshaw, Blackley, Manchester, England, assignors to Imperial Chemical Industries Limited, Westminster, England.—1,781,225.

Method and Apparatus for Distilling Solid Carbonaceous Material. Henry L. Doherty, New York, N. Y.—1,781,871.

Zeolite. Alphons O. Jaeger and Johann A. Bertsch, St. Louis, Mo.; said Jaeger assignor to the Selden Company, Pittsburgh, Pa.—1,782,353.

Method of Producing Rosin Oil. Joseph N. Borglin, Kenvil, N. J., assignor to Hercules Powder Company, Wilmington, Del.—1,782,401.

Active Carbon and Process for Making Same. Johannes van Loon, Deventer, Netherlands.—1,782,493.

Process of Purifying Anthracene. Charles J. Thatcher, New York, N. Y.—1,782,488.

Coke and Process of Producing the Same. Alfred H. White, Ann Arbor, Mich., assignor to The Regents of the University of Michigan.—1,782,556.

Manufacture of Alkyl Formates. Rudolf Wietzel, Ludwigshafen, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfort, Germany.—1,782,591.

Method of Producing Products of Hydrogenation of Alkylated Phenols. Hans Jordan, Berlin-Steglitz, Germany, assignor to Chemische Fabrik auf Actien, Berlin, Germany.—1,782,621.

Gas Producer. Anson K. Bradley, Worcester, Mass., assignor to Morgan Construction Company, Worcester, Mass.—1,782,677.

Process of Catalytically Hydrogenating Aromatic Amino Compounds and Products Produced Thereby. Felix Klingemann, Mainkur, Wilhelm Lommel, Wiesdorf, Ernst Korten, Fechenheim, and Theodor Goost, Leverkusen, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft.—1,782,729.

Process of Producing Compositions Containing Compounds of Alginic Acid and Product Thereof. Laurie Lorne Burgess, Cambridge, Mass., assignor to Plastic, Inc., Keene, N. H.—1,782,887.

Manufacture of Solvents. Joseph Hidy James, Pittsburgh, Pa., assignor to Clarence P. Byrnes, trustee, Sewickley, Pa.—1,782,963-4.

Method of Treating Ethyl Alcohol. Carl Haner, Moylan, Pa., assignor to Publicker, Inc., Philadelphia, Pa.—1,783,086.

Manufacture of Activated Carbon. Rudolf Defris, Stockerau, and Robert Wälder, Vienna, Austria.—1,783,110.

Inorganic Processes

Double-Superphosphate Manufacture. William Barkley King, Columbia, Tenn., assignor to Armour Fertilizer Works, Chicago, Ill.—1,780,620.

Process of and Apparatus for Slaking Lime. William H. Henderson, Youngstown, Ohio.—1,780,821.

Brine-Tank Evaporation Unit. John Karmazin, Detroit, Mich.—1,780,930.

Method for Refining Antimony by Electrolysis of Acid Electrolytes. Heinrich Roscher, Hamburg, Germany, assignor to Norddeutsche Affinerie, Hamburg, Germany.—1,780,944.

Process of Manufacturing High-Grade Zinc Oxide. Frederic E. Pierce, New York, N. Y.—1,781,702.

Process for Fixing or Recovering Chlorine. Edwin O. Barstow, Midland, Mich., assignor to the Dow Chemical Company, Midland, Mich.—1,781,830.

Production of Hydrogen. Frederick T. Snyder, New Canaan, Conn.—1,781,935.

Method of Making Hydrogen Peroxide. James B. Pierce, Jr., Charleston, W. Va., assignor to Barium Reduction Corporation, Charleston, W. Va.—1,781,859.

Recovery of Sulphur from Pyrites. Raymond F. Bacon, Bronxville, N. Y.—1,782,225-6.

Manufacture of Ceramic Products. Victor Moritz Goldschmidt, Oslo, Norway.—1,782,295.

Elimination of Sulphur Compounds from Gases. Gustav Wietzel and Josef Jannek, Ludwigshafen, and Fritz Fried, Mannheim, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort, Germany.—1,782,590.

Acid-Phosphate Plant. Ingenuin Hechenbleikner, Charlotte, N. C., assignor, by mesne assignments, to Chemical Construction Corporation.—1,782,821-4.

Process for Obtaining a Catalytic Gel. Ernest B. Miller and Gerald C. Connolly, Baltimore, Md., assignors to the Silica Gel Corporation, Baltimore, Md.—1,782,857.

Miscellaneous Processes and Equipment

Gyratory Crusher. Richard Bernhard, Allentown, Pa., assignor to Traylor Engineering & Manufacturing Company, Allentown, Pa.—1,780,459.

Apparatus for Separating Liquids into Constituents by Distillation and Rectification. Adolf Messer, Frankfort, Germany.—1,780,563.

Acid-Sludge Burner. Frank J. McDevitt, St. Louis, Mo.—1,780,653.

Filtering Device. Frank W. Young, Verona, N. J.—1,780,777.

Filter Bed. Andrew Lenderink, Kalamazoo, Mich.—1,780,791.

Fractionating Apparatus. Wayne Z. Friend, Charleston, W. Va., assignor to Baltimore Gas Engineering Corporation.—1,780,818.

Evaporator. Harlan W. How, Buffalo, N. Y., assignor to Buffalo Foundry & Machine Company, Buffalo, N. Y.—1,782,143.

Centrifugal Drier. Lee B. Green, Lakewood, Ohio, assignor to the Borden Company, Warren, Ohio.—1,782,264.

Apparatus for Cooling Fluids. Henry F. Merriam, West Orange, N. J., assignor to General Chemical Company, New York, N. Y.—1,782,435.

NEWS of the INDUSTRY

Olsen Elected President Of A. I. Ch. E.

TWO GROSS misconceptions about Southern pines have been responsible for the failure to develop a white-paper industry in the South, according to Dr. Charles H. Herty, whose public address before the American Institute of Chemical Engineers featured the annual meeting held in New Orleans, Dec. 8 to 10. The first is the belief that all such pine is too high in resin content for ordinary paper-making processes. While this is true of the heartwood of the large and older pines, Dr. Herty said most emphatically that it is not true of the sap wood of the younger slash pine. The second misconception is that the resin is a natural constituent always present in Southern pine. Actually it is the result of pathological action as the tree heals its wounds.

To prove his point, Dr. Herty cut 50 younger trees up to 8 in. diameter and had analyses made of the resin content. These showed no more or even less resin than the usual Canadian spruce. The wood was shipped to a sulphate mill and given standard treatment to produce a high-grade pulp, which required less bleaching than the Canadian product.

Disclaiming any discovery of a radically new process, Dr. Herty declared most emphatically that what the South needs is "the application of sound principles of chemical engineering in developing its natural resources and native wealth and not new discoveries or epoch-making inventions. Modern chemical engineering practice backed by complete chemical control has made successful many unpromising developments such as pinewood distillation and sulphur recovery. The Southern industries that most need this influence now are paper, salt, and sugar."

MORE than 200 chemical engineers and guests attended the technical sessions, at which the fifteen papers reported elsewhere in this issue were presented and discussed. Plant visits were made to the Marerro works of the Celotex Company and the Baton Rouge refinery of the Standard Oil Company of Louisiana. Following the meeting a large party chartered a special train for a two-day trip to New Iberia, through the historic Teche and Evangeline country west of New Orleans, where great natural resources are awaiting chemical engineering development. Other groups visited plants in Bogalusa, La., and Hattiesburg, Miss.

Intense interest among members centered in discussion of an amendment proposed in a petition submitted by Dr. A. C. Langmuir and 22 other members which had for its purpose the return to the institute's constitution the requirement of "proficiency in chemistry" recently displaced by ballot vote of the membership in favor of "proficiency in chemical engineering." In considering the proposed amendment prior to the annual meeting, the council voted eleven to two to favor its defeat so a representative committee might give more thorough study to the problems of the definition involved.

At the annual business session, following animated discussion by twenty or more members, it was voted, 43 to 17, that the meeting also go on record in opposing the amendment. It was further decided that in submitting the amendment to the membership prior to Jan. 1 it should be accompanied by two statements summarizing the viewpoints.

Prof. John C. Olsen, of the Polytechnic Institute of Brooklyn, was elected president by the ballot of membership reported at this meeting. The new vice-president is John Van Nostrand Dorr, president of the Dorr Company. Frederic J. Lemaistre, for the past year executive secretary, was elected secretary to succeed Dr. H. C. Parmelee. Dr. Martin H. Ittner, of Jersey City, and Dr. David Wesson, of Montclair, were re-elected as treasurer and auditor, respectively. The four new directors elected were Prof. Harry A. Curtis, of Yale; Robert E. Wilson, of the Standard Oil Company of Indiana; Webster N. Jones, of the B. F. Goodrich Company; and J. Leroy Bennett, of the Hercules Powder Company.

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Solid Carbon Dioxide In Argentina

IN A report from Assistant Trade Commissioner M. T. Houghton, Buenos Aires, it is stated that there are two plants producing solid carbon dioxide in Argentina, the St. Hermanos and the Simon Mattoldi. The St. Hermanos plant uses coke to produce the gas and compresses it in three stages of 11, 18, and 70 atmospheres pressure. The Simon Mattoldi plant, also a large producer of alcohol, obtains its gases from the fermentation of molasses, used in producing alcohol.

Third International Coal Conference

A THIRD international conference on bituminous coal will be held at the Carnegie Institute of Technology in November, 1931, according to a recent announcement made by Dr. Thomas S. Baker, president of the Institute of Technology and organizer of the first two international congresses.

The purpose of the congress, President Baker announced, will be similar to that of the meetings held in 1926 and 1928: to present for discussion the results of recent studies of coal. Particular attention will be paid to the economics of the new methods and processes that are being evolved, he indicated.

The program will include papers on carbonization, liquefaction and gasification of coal; byproducts of coal; the mechanism of combustions; cleaning of coal and its preparation for the market; pulverized fuels; power plants; and domestic heating. The discussions will be confined to coal above ground. Beginning at the mouth of the mine, however, practically every phase of distribution and consumption will be treated by outstanding authorities in the several fields.

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Chemical Trade Appoints Employment Committee

THE Chemical Division Committee of Emergency Employment Committee for the Borough of Manhattan, New York City, was organized on Nov. 26 by Horace Bowker, chairman. The committee is: Horace Bowker, chairman, president, American Agricultural Chemical Company; A. W. Goeller, treasurer, American Agricultural Chemical Company; George A. Benington, president, Bowker Chemical Company; Howard Huston, secretary, executive committee, American Cyanamid Company; Charles E. Adams, chairman of the board, Air Reduction Company; Joseph Turner, president, Jos. Turner & Company; Herman B. John, manager, Grasselli Chemical Company; H. R. Wemple, sales manager, Texas Gulf Sulphur Company; Ralph E. Dorland, manager, Eastern office, Dow Chemical Company; Edwin M. Allen, president, Mathieson Alkali Works; Robert T. Baldwin, secretary, The Chlorine Institute, Inc., and Louis Neuburg, vice-president, Warner Chemical Company.

Methanol Approved for Anti-freeze Use

IN RESPONSE to a request by the producers of synthetic methanol, the U. S. Bureau of Mines has investigated the effect of methanol on health, and the preliminary results have been published by R. R. Sayers, chief surgeon, U. S. Bureau of Mines; surgeon, U. S. Public Health Service; and W. P. Yant, supervising chemist, health laboratory section, U. S. Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.

The Bureau of Mines experts conclude that the reasonable use of methanol as anti-freeze for automobile radiators involves no danger to health. The full summary and conclusions of the report follow:

"The information which the Bureau of Mines has obtained to date indicates that there is no hazard to health from the reasonable use of methanol for anti-freeze purposes. Many of the conditions of exposure to vapor and by contact with the skin, which were observed in the manufacture of methanol and for which no health hazard was found, are very comparable to the degree of exposure observed in usage as an anti-freeze. Also the exposures in both cases are below those which laboratory experiments with animals have indicated to be harmful.

"The investigation is being continued for the completion of information on the toxicity of methanol, particularly from the viewpoint of obtaining more comprehensive data regarding allowable concentrations for industrial uses and for investigating further the mechanism of methanol poisoning. Also, while there are no reasons to believe danger to health will occur in the use of the product as an anti-freeze, the Bureau of Mines will observe its use throughout the present winter, as this procedure is always desirable where new uses of products involve the question of hazard to health.

"The following conclusions and recommendations are based on studies and observations to date.

"Observations made by the Bureau of Mines have indicated that there is no danger of poisoning from the reasonable use of methanol as an anti-freeze for automobile radiators.

"The evidence that methanol poisoning has been caused by absorption through the skin is rare and inconclusive.

"Practically continuous exposure to low concentrations and short intermittent exposure to high concentrations of methanol cause no apparent harm; but, on the other hand, continued exposure to high concentrations will cause serious poisoning.

"All methanol, whether made by wood distillation methods or synthetic methods, or whether it is crude, refined, or highly purified, is poisonous when taken internally. It will cause serious poisoning, blindness, and possibly death when as little as 2 oz. is taken into the stomach.

"To avoid misuse it is recommended that in the future all anti-freeze methanol be brightly colored to enable garage attendants and the public to identify it as methanol; and to warn against misuse, particularly for beverage purposes.

"The largest producers of methanol anti-freeze label their containers so as to call attention to the hazards of misuse of methanol and also issue information and instructions to garage attendants and the consuming public warning against its misuse. It is recommended that these precautionary measures be adopted by all producers."

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A. S. M. E. Forms Process Industries Committee

AT A conference of the Process Industries Committee of the American Society of Mechanical Engineers held in New York on Dec. 3 during the regular annual meeting of the society, steps were taken toward the formation of a Process Industries Division. The committee elected as chairman Prof. Carlo Harrington, of Buffalo University. Victor Wichum, chief engineer of C. J. Tagliabue Mfg. Company, Brooklyn, was made secretary. A committee of three representing the American Institute of Chemical Engineers included Crosby Field, C. O. Brown, and C. R. Downs. During the meeting it was proposed that a joint committee representing both the A.S.M.E. and the institute should, if the plan meet with the approval of the two organizations, be appointed to coordinate activities. Further members of the Process Industries Committee are to be appointed within the next few weeks, and it is expected that sufficient interest will be evident to justify approval of the group as a separate division of the society.

In outlining the scope of the proposed division, Professor Harrington explained that the new group would deal with the engineering phases of design, manufacture, and operation of equipment in industries in the process field, and that the industries concerned included chemicals, coal-tar products, explosives, coal processing, sugar refining, pulp and paper, cement and lime, soap, fertilizer, paint and varnish, rubber, ceramics and glass, vegetable oils, food processing, and leather.

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New Salt Company for British Columbia

THE Arden Vancouver Salt Company has purchased a site at False Creek, Vancouver, with a view to constructing a plant for grinding and milling salt. An initial outlay of about one hundred thousand dollars is involved in the purchase of the property on the water frontage. Building is to commence at once, and the plant will be ready to start production by Feb. 1, according to H. P. Lougheed, secretary of the firm. The Arden Salt Company of California, which has been a factor in the British Columbia market for some time, has withdrawn, and the Vancouver company is taking its place.

New Denaturant for Industrial Alcohol

ALCOTATE, a new denaturant, will be substituted for methanol in all completely denatured alcohol formulas, effective Jan. 1, according to an announcement by Dr. J. M. Doran, Commissioner of Industrial Alcohol. Elimination of methanol in specially denatured formulas also is contemplated, but Commissioner Doran explained on Dec. 11 that such action will require further consideration before it is made effective. The Commissioner's decision to abandon the use of the poisonous denaturant had been anticipated for some time, as chemists of the Bureau of Industrial Alcohol had been working on the development of a non-poisonous but bootleg-proof denaturant for the past three years. Action by Commissioner Doran probably was hastened by renewed agitation in Congress this session against continued use of toxic denaturants in industrial alcohol, although an amendment to this effect proposed by Representative Linthicum, of Maryland, chairman of the unofficial Committee for Modification of the Volstead Act, to the Treasury Department appropriation bill was voted down 106 to 54 on Dec. 5.

Alcotate is a derivative obtained from California petroleum in the cracking process and is extremely obnoxious both in odor and taste. Commissioner Doran is convinced that the new denaturant cannot be removed from industrial alcohol by any chemical process, thus preventing the use of alcohol so denatured as a beverage. It has been subjected by the Bureau's laboratory to all known "bootleg" treatments, such as filtering through carbon and fractional distillation in column stills.

The present completely denatured formulas to which, said Mr. Doran, an increasing number of fatalities has been attributed, contain 4 per cent of natural wood alcohol and three-quarters of one per cent of aldehol. The new formulas will substitute for the wood alcohol 1 per cent of alcotate and increase the aldehol content to 1 per cent.

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Insecticide Manufacturers Hold Convention

THE annual meeting of the Insecticide and Disinfectant Manufacturers' Association was held at the Hotel McAlpin, New York City, Dec. 8-10. In addition to transaction of regular business, including reports of officers and committees, several papers were read.

At the closing session on Dec. 10, Robert C. White, of the R. C. White Chemical Company, Philadelphia, was re-elected president. Other officers include: Evans E. A. Stone, of William Peterman, Inc., New York City, first vice-president; E. B. Loveland, Stanco Distributors, Inc., second vice-president; Harry W. Cole, Baird & McGuire, Holbrook, Mass., secretary; and John Powell, New York City, treasurer.

NEWS FROM WASHINGTON

By Paul Wooton

Washington Correspondent of Chem. & Met.

PUBLICATION by the Bureau of Mines of a preliminary report in which Dr. R. R. Sayers, chief of the health and safety branch, states that his investigation indicates no danger of poisoning from the reasonable use of methanol as an anti-freeze, was followed immediately by a statement from Henry C. Fuller, consulting chemist of Washington, D. C., declaring that methanol is "a sure and certain poison no matter how it is used," and charging that the Bureau's report may lull the public into an unwarranted feeling of security.

It is estimated that 30 per cent of the production of methanol now is finding a market as an anti-freeze in competition with denatured ethyl alcohol, glycerine, and prestone.

Mr. Fuller raises the question whether there are any purposes for which methanol is now employed that cannot be served just as well by solvents that are "comparatively innocuous," and answers it by stating "it would seem that in our economic life the public health can best be conserved by dispensing with its use to the minimum limit." In Mr. Fuller's opinion the traffic in methanol ought to be regulated just as rigidly as the traffic in other poisons, and he suggests that where it has to be handled for manufacturing purposes it should be properly denatured and sold under restrictions similar to those applying to industrial alcohol.

The investigation of the Bureau of Mines was undertaken under a co-operative agreement with the Carbide & Carbon Chemicals Corporation, DuPont Ammonia Company, and the Commercial Solvents Corporation. This is emphasized in the statement by Mr. Fuller, who sets against the findings of the Bureau a report quoting Reid Hunt, Birch-Hirschfield, Pohl, Dr. R. H. Price, assistant medical director of E. I. duPont de Nemours & Company, and other scientists.

THE Bureau's investigation entails a laboratory study of the toxicity of methanol when acquired by inhalation and skin absorption, and a field investigation of the amount of methanol vapor to which persons are exposed in closed cars and in private and public garages due to the escape of vapor from the radiator, or spillage and drip. The exposure of the garage or filling station attendant while dispensing methanol also is considered. The conditions under which the tests are being made range from normal operating conditions to overheated engines and boiling radiators.

The findings in the Bureau's preliminary report are based upon an investigation of the exposure and health experience in the manufacture of methanol, as this has afforded information based on long experience productive of earlier information on continued exposure than could be obtained to date from a study of its use as an anti-freeze. The conditions of exposure prevailing in four plants have been surveyed and physical examination of 36 men who have worked in these plants for periods of a few months to 10 to 15 years revealed no acute or chronic illness and no defective vision or eye pathology attributable to methanol. Blood and urine analysis revealed no indication of deleterious action, although methanol was found in both in a considerable number of cases after comparatively severe exposure during several hours' work. This substantiates past experience, according to Dr. Sayers, that certain amounts of methanol can be acquired without apparent harm.

MANY of the conditions of exposure to vapor and by contact with the skin, observed in the manufacture of methanol, for which no health hazard was found, are described as comparable to the degree of exposure observed in the use of methanol as an anti-freeze. The exposures in both cases, says Dr. Sayers, are below those which laboratory experiments with animals have indicated to be harmful.

The Bureau's investigation will be continued for the purpose of obtaining more comprehensive data regarding allowable concentrations for industrial uses and for investigating further the mechanism of methanol poisoning. While Dr. Sayers is satisfied that there is no danger to health in the use of the product as an anti-freeze, both he and W. P. Yant, supervising chemist in the health laboratory at the Pittsburgh experiment station, will continue to observe its use this winter with a view to supplementing, if necessary, their conclusions and recommendations, presented below.

OPERATION of the new class freight rate scales again has been postponed ostensibly because of the inability of the railroads to complete preparation of the tariffs before April 1. Even longer postponement of the rates intended by the Interstate Commerce Commission to become effective last November is probable, as both Eastern and Western roads have asked for reconsideration by the Commission, declaring that its findings do not afford a sufficient increase in revenues.

Revision of the interstate class rate structure in Eastern territory probably is of more importance to the chemical industry than any previous rate decision by the federal commission. Rates on freight of the first four classes have been materially increased. These include most of the finer chemical products. Rates on fifth and sixth class freight, which, generally speaking, include heavy raw materials and chemical products of low grade, show little, if any, increase. In asking for reconsideration by the Commission, the railroads stress the failure of the Commission to step up rates in classes embracing the largest proportion of class freight traffic.

The Interstate Commerce Commission has amended the regulations governing transportation of dangerous articles by freight to permit shipment in tank cars of anhydrous hydrofluoric acid, which is used for the manufacture of difluodichloro-methane, the new refrigerant developed by General Motors research laboratories.

IF CONCESSIONS made by the government in consideration of the new regulations governing industrial alcohol are incorporated in the final draft, the alcohol-using trades will have won their fight for elimination of the principal objectionable features contained in the original draft. The regulations will be issued in final form in the near future and presumably will become effective Jan. 1. At a final meeting of the advisory council organized by J. M. Doran, Commissioner of Industrial Alcohol, to represent the trades affected, both Commissioner Doran and A. W. W. Woodcock, Director of Prohibition, expressed assent to eliminating a provision that would have made the seller responsible for unlawful diversion by the buyer of products in which alcohol is a constituent. The representatives of the alcohol-using trades also received some assurance that the regulations setting up joint control by the Department of Justice and the Treasury Department over the issuance of permits also will be modified with a view to eliminating delays promising to interfere with manufacturing operations. A restatement of such provisions will be submitted to the advisory council for criticism before the regulations are issued.

An attempt on the part of manufacturers of completely denatured products to eliminate the use of methanol as a denaturant is seen in the permission granted to them by Commissioner Doran to reduce temporarily from 4 to 2 per cent the proportion of natural wood alcohol in products made under completely denatured alcohol formula No. 5, provided that the aldehol content is increased from three-quarters of one per cent to 1 per cent. This modification of the No. 5 formula is nominally effective until Jan. 1 but may be terminated at a slightly earlier date. Short supplies of the natural wood alcohol are attributed to the demand for its use in anti-freeze solutions, but the question has arisen in some quarters why the ethyl alcohol manufacturers failed to assure themselves in advance of an adequate supply of methyl alcohol for use as a denaturant of their product.

Industrial Conditions in France Show Improvement

National Equipment Bill Expected to Aid Home Manufactures

From Our Paris Correspondent

ACCORDING to indications, the economical depression is lessening. Industrial and chemical shares, for instance, have risen appreciably, confirming the optimistic outlook of recent days. A slight rise in the prices of raw materials confirms this favorable impression. It should be noted that the slump of prices for raw materials did not affect retail prices, which remained high, thus holding up the cost of living.

Another stimulant for trade will be the coming into force of the national equipment bill, which, according to rumors, will be voted shortly. For five years the state will supply the main home industries with orders worth seventeen and a half billion French francs, thus helping the aforesaid industries to recover from the present commercial crisis.

A few words should be said on the League of Nations' Economic Committee activities at Geneva. The Economic Committee now holds an international custom conference between all members of the League, the custom truce first proposed having been replaced by an economical concerted action agreement, but so far no definite results have been known.

The British delegation favored the lowering of all existing custom tariffs; the French delegation contended that all present custom tariffs which are more or less the same as in 1927 should be maintained and that only partial adjustments clearly defined should be made. The Dutch delegation's proposition seems to rally the majority of voters, as it divides all nations into two groups, one which though refusing to tie itself by free trade tariffs endeavors to apply most liberal custom tariffs in all dealings with foreign countries, and a second which is inclined to readjust as liberally as possible but only partially its present tariffs, but wishes, however, to remain more or less protectionist.

GENERALLY French industrial circles state that the present custom tariff is rather too moderate and we have already mentioned a striking example: the turpentine producers' complaints against all importers of foreign turpentine or turpentine substitutes—white spirit especially.

The use of white spirits has increased enormously since the World War, for, during that period and shortly after, white spirit was frequently used as a substitute for turpentine, which had reached prohibitive price levels. Today the prices of turpentine have dropped and rosin gatherers of the Landes districts not only ask heavier custom duties on all mineral oil byproducts which may be used as substitutes to turpentine in the manufacturing of colors but also on foreign rosin and turpentines. Moreover, they want legal steps taken against all manufacturers of so-called turpentine-made goods such as colors, floor waxes, varnishes, etc., if these goods are partly made with turpentine substitutes, however small this part may be.

Turpentine is used also as raw material in the manufacture of raw camphor. The Société Alsacienne de Produits Chimiques produces at La Rochelle up to 2,000 kilos of synthetic camphor per day. The manufacture of synthetic camphor is less remunerative at present, however, as its price per kilo has dropped from 29 to 20 fr., but even at that price it was said at the last shareholders' meeting that the manufacture of synthetic camphor was not unprofitable. This statement appears to be too sanguine, for the above named firm lost 4,000,000 French francs in 1929. The main disadvantage of the process used is that only part of the turpentine is transformed into synthetic camphor, which yields many byproducts such as limonen, dipenten, etc., which up to now cannot find a market. Presumably the Société Alsacienne de Produits Chimiques will separate by distillation nopinen which cannot be totally transformed into camphor. In the latter case turpentine not having been submitted to chemical action after separation from nopinen may be sold at a favorable price. This is undoubtedly one of the reasons which will cause this process to be adopted.

Turpentine, it should be remembered, is used not only in the synthesis of camphor but also in that of terpine and terpineol, the latter producing byproducts difficult to dispose of. Recently endeavors were made to sell them mixed with pure turpentine. The rosin gatherers of the Landes districts immediately took legal steps against the manufacture of this mixture, since, for obvious reasons, the manufacturer had omitted to mention that his product was not pure turpentine.

Should the Dutch proposition be adopted at Geneva the Economic Committee of the League of Nations will have to draw a double international agreement according to the country dealt with. Other points besides custom tariffs are being warmly discussed at Geneva such as the definition of a nation's financial credit, the organization and co-operation of the different international markets, international railways agreements, etc., and all these questions have to undergo several changes and alterations when discussed before being approved by all.

The president of the Société d'Electro-Chimie, Electro-Metallurgie & des Acièries Electriques d'Ugine, M. Henry Gall, died recently. He was one of the leading French manufacturers of electro-chemical products, chlorates, calcium carbide, and cyanamide. During the war he was elected president of the Society of Civil Engineers of France.

Hearings Held on Salt Cake Dumping

SALT CAKE was the subject of a hearing before the Bureau of Customs on Dec. 5-6. A charge that German salt cake had been dumped in domestic markets had been charged.

Representing the Sodium Products Corporation of San Francisco, Calif., as its attorney, Jesse Crawford stated that there was a "dumping" of from 13,000 to 14,000 tons of German salt cake on United States markets during the first four months of 1929. This, he stated, exceeded by over 2,000 tons the total imports of salt cake into this country in 1927 and it is something from which the domestic producers need relief.

Placing any substantial duty upon foreign salt cake imported into the United States would very likely increase the cost of producing kraft paper in the United States, for which commodity salt cake is a necessary raw material, so as to make it impossible for American kraft paper concerns to produce in competition with outside companies, and thereby result in their going out of business, it was stated by Oliver M. Porter, manager of the National Kraft Paper Manufacturers' Association.

American industries dependent upon salt cake for their business have decided that they need a free duty on foreign salt cake in order to continue successful operation. It was impossible for American kraft paper producers to obtain adequate domestic supplies of salt cake during the early part of 1929, Mr. Porter said, because there was a shortage of that product in this country. Therefore, he stated, the importation of German salt cake was necessary and there was clearly no "dumping" of that commodity on our markets. "We strongly object to any increases in duty on foreign salt cake which would substantially increase our costs," he said.

Arthur J. Siegel, vice-president of the M. Gottesman & Company, Inc., New York City, said that an analysis of the facts indicate that there was no "dumping" of German salt cake on American markets during the period in question. "Prices did not decline as a result of these foreign importations, as there was a scarcity of salt cake in the United States at that time." The American consumers of this product are actually dependent upon foreign importations.

The matter was taken under advisement, with no indication given regarding whether or not an anti-dumping order would be recommended.

Developments in Gas Liquefaction In Germany

Possibility of Reducing Cost of Oxygen Regarded as Favorable

From Our Berlin Correspondent

THE PERIOD of economic difficulty continues unabated. An interesting result, however, has been the memorandum from the Relief Committee of German Science, whose membership includes all the higher schools and scientific societies, in which a stand is taken in the interests of the German economic and labor situation, as well as of sound sociology and technology. It contends that any restriction in scientific work, apart from the danger to Germany's science in general, would represent a serious weakening of German producing power and that, under no conditions, would it be salutary to undertake the reduction of federal subventions.

The consumption of fuels of all sorts has improved very slightly or not at all, in spite of the advent of the cold season. The necessity of price reduction all along the line has caused the Rheinisch-Westfälische Kohlensyndikat to cut prices about 6 per cent from Dec. 1 on, although costs have not been reduced, but only under the condition that mining wages may be lowered, which is not certain yet. The Rheinisches Braunkohlensyndikat also has effected a reduction in the retail price of house briquets from 0.80 to 2.0 m. per ton; this policy, however, is a sign of successful competition of lignite against coal, which began during the war.

A company has been formed for thorough exploration of the petroleum deposits in Pomerania. Considerable deposits have been found here as well as in the Kassel and Hanover districts in recent months. The price situation in the petroleum products market is more confused than ever. A small group, which the Russians have joined, has tried to maintain prices, nevertheless underbidding by financially strong firms is becoming ever more general. The German affiliates of large foreign petroleum companies, in connection with the German Gasolin A.G., which distributes synthetic benzine for the I.G., and with the Benzol Association, have acquired 51 per cent control of the Reichskraftspiritus G.m.b.H. The reason for this transaction is not yet known.

THE accumulation of stocks of coke in the western Upper Silesian region has caused the Glückauf works in Hindenburg to shut down.

Germany's chemical exports suffered their sharpest reverses for the first half year of 1930, in comparison with 1929, along the line of basic chemicals, acids, salt, and so on. The decline was 3½ per cent in quantity and 9½ per cent in value. The imports of chemicals to Germany declined in the same period by 15 per cent in value, but increased by ½ per cent in quantity. The synthetic nitrogen plant of the Mont Cenis firm, which was acquired by the I.G. and shut down, is now being operated as an experimental plant.

The preparation of natural phosphate into easily soluble fertilizer salt without filler, has created a new branch of chemical industry. By reduction, phosphorus is produced from mineral phosphate and is then oxidized with steam into phosphoric acid by a process of Lilienroth, recently improved by B. Schätzel. He passes a mixture of phosphorus and steam in regulated flow over a Monel metal contact. By suddenly inhibiting the mixture, the phosphoric acid is not broken down and the formation of phosphorous acid, a difficulty in the Lilienroth process, is presented.

NEW developments in gas liquefaction have opened the possibility of reducing very considerably the cost of oxygen, so that this gas, which ordinarily is not demanded in great purity, becomes available for use in blast furnaces. Liquefaction by means of new rectifying columns permits an almost perfect separation of the constituents of the air and the achievement of very pure products. An installation which separates 2,000 cu.m. of air each hour and produces 5,000 cu.m. of pure nitrogen requires about 0.2 hp. for each k.g. of nitrogen. Such installations have been running uninterruptedly and automatically for as much as eight months. The reduction of gases containing hydrogen—for example, coke-oven gas for ammonia synthesis—has become possible through this new rectifying process. Meanwhile, a blast furnace using air enriched with oxygen is being placed in operation in the Ruhr district. This new installation for oxygen consumption in a metallurgical plant is significant not only from the standpoint of fuel technology but also of the regulation of the product to be obtained.

For scrubbing ammonia and benzene in quantities up to one-half million cu.m. of gas, daily, the firm of Walter Feld & Company, G.m.b.H., Essen, is building a Feld scrubber measuring 4.5 m. in diameter and about 12 m. in height. The company has already built 26 such scrubbers for a daily quantity of 5.8 million cu.m. of gas. Their applications extend to the washing of napthalene, ammonia, benzol, alcohol, acetone, gasoline, and so on. The efficacy of the washing fluid in these scrubbers is very high and hence the size and operating costs of the process are far lower than in other systems. The modified Feld-Gisner scrubber, for the washing and mixing of fluids of different specific weights, has long been tried and proved in scrubbing phenol from liquors.

The use of non-oxidizing lubricants is required in certain chemical operations where oxidizing materials, such as potassium chlorate or peroxides, are handled. For this purpose the I.G. Farbenindustrie offers a solution in the form of highly concentrated potassium phosphate (K_2HPO_4). With a specific gravity of 1.8, the solution has the properties of a medium machine oil at 20 deg. C. viscosity of 20 Engler deg., and at 50 deg. a viscosity of 4 Engler deg. It is produced by the neutralization of technical phosphoric acid of 48 deg. Bé., with solid caustic potash. By the addition of water or the removal of undissolved particles the solution is then brought to the proper consistency. It can also be mixed for special purposes with graphite, talc, and other such useful fillers.

The explosives developed by Stettbacher, Zurich, and recently reported here, were further discussed by Dr. Naoum, the eminent expert on explosives. The action obtained by the mixture of the two well-known explosives, nitroglycerin and nitropentaerythrite, is not really a new one. Some of the conclusions drawn from this development are also somewhat extravagant. The so-called universal explosive is not especially desirable for mining, even in cases where high brisance is desired, because it unfortunately cannot yet compete with perfectly satisfactory materials now available at lower prices.

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Nitrite Tariff Case Again Debated

THE motion of the government to dismiss the suit brought by the Norwegian Nitrogen Products Company, challenging the procedure of the Tariff Commission, under the so-called flexible provisions of the Tariff Act, in investigating and recommending an increase in the rate of duty on sodium nitrite, was taken under advisement Nov. 24 by the U. S. Customs Court for the First Division, sitting specially in Washington.

Following the assessment of duty at the rate of 4½ cents a pound on sodium nitrite pursuant to the proclamation of the President issued after the Tariff Commission reported the result of its investigation, the Nitrogen Products Company filed protests in which it was claimed that the assessment of the higher rate was illegal and without warrant of law. The protests also contended that "contrary to the recital in the proclamation the Tariff Commission did not as provided by law and the rules of the Commission during the investigation give reasonable public notice and did not afford interested parties a reasonable opportunity either to be present or produce evidence," and that therefore the proceedings of the Tariff Commission were without authority of law.

MEN IN CHEMICAL ENGINEERING

J. B. JOHNSON has been appointed superintendent of the Hercules Powder Company's plant at Hercules, Calif., to succeed B. F. Bierbauer, who recently died.

FREDERICK O. ANDEREGG, formerly associate professor of physical chemistry at Purdue University and then senior industrial fellow at the Mellon Institute of Industrial Research, has opened a consulting office on building materials and cement products at Pittsburgh.

JOHN C. OLSEN, professor of chemical engineering at the Polytechnic Institute, Brooklyn, N. Y., was elected president of the American Institute of Chemical Engineers for the coming year at the annual meeting in New Orleans on Dec. 9. Dr. Olsen is one of the founders

of the society and has been active ever since in its affairs, as secretary, director, and vice-president. He was educated successively at Knox, Johns Hopkins and Chicago University, and has devoted his subsequent career to teaching. Before he came to Brooklyn Polytechnic Institute he was head of the chemistry department at Cooper Union. Dr. Olsen is a native of Galesburg, Ill., where he was born in 1869.

C. E. MILLER has joined the laboratory of Foster D. Snell at Brooklyn, coming from the Puritan Soap Company, Rochester.

THEODORE N. HUBBUCH has joined the American Potash & Chemical Corporation, New York, for work on technical sales.

W. S. BRIMIJOIN has been appointed superintendent of the Hercules Powder Company's plant at Emporium, Pa., to succeed J. B. Johnson, who has been transferred.

VALENTINE C. SMITH, formerly vice-president and general manager of Kelly Graphite Mills, Stockertown, Pa., has resigned to accept a similar position with the Bloomsbury Graphite Company, at Bloomsbury, N. J.

H. A. HOFFMAN, formerly with the B. F. Goodrich Company and more recently chief chemist of the Mason Tire & Rubber Corporation, has joined the technical organization of the Roessler & Hasslacher Chemical Company as a member of the rubber division. His first technical experience was with Eli Lilly & Company at Indianapolis, Ind., but he joined the Goodrich concern in 1910 and was long active there in technical development work.

W. T. DOYLE and H. A. TOMLINSON have been appointed vice-presidents of the Sturtevant Mill Company, Boston, after being active in equipment design and in research as engineers of the company.

ELWIN E. HARRIS, for the past seven years professor of organic chemistry in the University of North Dakota, has joined the section on derived products of the U. S. Forest Products Laboratory, for a new intensive investigation of lignin.

LAURENCE V. BURTON, since its inception a member of the editorial staff of *Food Industries*, has been appointed as its editor by the McGraw-Hill Publishing Company. Before his entrance into editorial work, Dr. Burton had long practiced the function of the chemical engineer in the manufacture of foods and the rôle of fundamental science in industrial technology. After graduation as chemical engineer from the University of Illinois, where he also received his master's degree, he studied bacteriology at Yale University to obtain his Ph.D. degree. He began his industrial experience as foreman and chemist for canning companies in Wisconsin and Illinois, later entering the laboratory of Libby, McNeill & Libby. During the World War he was with the Food and Nutrition Department of the Sanitary Corps, and then, after returning, became director of inspection service for the National Canners' Association in Illinois. After a varied connection with this organization, he joined the Libby firm again in the general superintendent's department, finally taking charge of operations in the company's Colorado plant. Later he under-

took development work for the Foulds Company, interested in various food products, and established and operated its plant at Franklin, Ind. In the interval before he came to the newly organized *Food Industries*, he devoted his energy to a consulting practice.

CALENDAR

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Swampscott, Mass., June, 1931.

AMERICAN CHEMICAL SOCIETY, 81st meeting, Indianapolis, March 30-April 3, 1931.

ELECTROCHEMICAL SOCIETY, spring meeting, Birmingham, Ala., April 23-25, 1931.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY, annual meeting, New York, Feb. 16-19, 1931.

OBITUARY

ROBERT W. PARSONS, of the Pittsburgh Plate Glass Company, lost his life as a result of an explosion in a mine in Ohio which he was inspecting with his associates. He was a member of the conservation committee of the Portland Cement Association and was known as an authority on closed circuit grinding.

RICHARD MOLDENKE, metallurgical and mining engineer and expert on foundry practice, died in Plainfield, N. J., on Nov. 17 following an operation. The member of an eminent Lutheran family, he was born at Watertown, Wis., in 1864, but spent most of his career in the East. His activities were various and fundamental, many institutions and personalities testifying to his stimulating and creative force. Happily, it was the good fortune of many to come in contact with him recently at a forum on "gray iron," on which he was an authority, conducted as part of the last sessions of the Electrochemical Society, where his listeners grouped around him informally to learn in a direct, personal way from one of the foremost teachers in industrial metallurgy.

MARKET APPRAISAL OF CHEMICAL INDUSTRY

WITH the announcement by H. T. Dunn, president of the Fisk Rubber Company, that depletion of working capital would make it impracticable for the company to refund its issue of $8,199,500 of 5½ per cent notes, maturing on Jan. 1, it was said that three protective committees, representing holders of the company's stocks, bonds, and notes, had been formed.

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The American Agricultural Chemical Company announces that it will redeem $2,000,000 of its first refunding mortgage 7½ per cent bonds on Feb. 1 at 102½. This amount includes the $1,000,000 previously announced as about to be called. This call will reduce the bonds of the issue outstanding to about $5,500,000, compared with $8,890,000 outstanding as of June 30, 1930, when the company's annual report was issued.

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The Tennessee Copper & Chemical Company has changed its name to the Tennessee Corporation. An expansion program involving the expenditure of $2,000,000 is announced.

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Allied Chemical & Dye Corporation has declared a stock dividend of 5 per cent on the 2,287,442 shares of no-par common stock outstanding.

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Stockholders of Will & Baumer Candle Company, Inc., have voted to increase the authorized common stock to 150,000 shares from 100,000 shares. There is no present intention of issuing additional stock.

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Report of Canadian Industrial Alcohol Company, Ltd., for the year ended Sept. 30 shows net profit of $523,770 after depreciation, federal taxes, etc., equivalent to 48 cents a share on 1,092,666 no-par shares of combined Class A and B stocks. This compares with $2,073,977, or $1.89 a share, on 1,092,915 combined shares, in previous year.

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Monsanto Chemical Works has declared the regular quarterly dividends of 31¼ cents in cash and 1½ per cent in stock. Directors announced that the stock dividend payments would be discontinued with the present declaration and that future dividends would be paid in cash.

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The Libbey-Owens-Ford Glass Company has reported net profits of $1,419,303 for the fiscal year ended Sept. 30, after all charges and taxes, and including profits of the Edward Ford Plate Glass Company from July 1, 1930. The net was equal to 63 cents a share on the outstanding capital stock. There was a net loss of $260,592 for the quarter ended Sept. 30.

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Liquid Carbonic Corporation reports net income of $2,011,087 for the year ended Sept. 30, after charges, which was equal to $5.22 a share after dividends on the management shares and a reserve of $100,000 for receivables and collection expenses. This compared with $1,903,528, or $5.67 a share, in the previous fiscal year.

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The Gold Dust Corporation has announced that it was prepared to purchase up to Dec. 22 any amount of the American Cotton Oil Company's debenture 5 per cent bonds due May 1, 1931, at 101 and accrued interest. The debentures must be delivered at the First National Bank, New York, where payment will be made.

Price Range 1930 High	Price Range 1930 Low	Stock	Price Range in November — Nov. 1	High	Low	Nov. 29
34	16	Agfa Ansco Corp.	....	....	....	....
156½	91½	Air Reduction	101½	108	91½	103
2½	½	Ajax Rubber	¾	¾	¾	....
343	185½	Allied Chemical	200½	212	185½	198½
356	150	Aluminum Co. of America	....	189	150	163
10¼	1½	Am. Ag. Chemical	2½	2½	1½	1½
33	9	Am. Commercial Alcohol	12½	13½	9	11½
37	10	American Cyanamid, B	10¼	12½	10	10½
7	2½	American Hide & Leather	....	2½	2½	....
51½	18½	American Metals	....	24½	20½	21½
22½	3½	Am. Solvents & Chemical	4½	4½	3½	4
43½	13½	Anglo. Chile Nitrate	....	20	13½	14½
29½	16½	Archer-Daniels-Midland	19½	19½	16½	16½
8½	2½	Armour, Ill., A	....	4½	2½	4
51¼	18¼	Atlantic Refining	21¼	23½	18¼	21½
106	53	Atlas Powder	....	58½	53	....
70½	46½	Beechnut Packing	....	53	46½	....
5½	1¼	British Celanese	....	2½	2½	....
35	21	California Petroleum	....	22	21	....
20	10	Celluloid Corp.	12½	12½	10	....
15½	3½	Certain-teed	4½	4½	3½	....
32½	14	Chickasha Cotton Oil	....	15½	14	....
64¼	47½	Colgate-Palmolive-Peet	50½	52	47½	49½
199	81½	Columbian Carbon	87½	96	81½	90½
38	14½	Commercial Solvents	18	19½	14½	17½
111½	72½	Corn Products	76½	82½	72½	79½
43½	15	Davison Chemical	18½	18½	15	16½
42½	17½	Devoe & Raynolds, A	....	19½	17½	....
100	49	Dow Chemical	....	51½	49½	51½
145½	83	Du Pont	89½	95	83	87½
123	114½	Du Pont, 6 pc. deb	118½	119	116½	....
21	2	Duval Texas Sulphur	2½	2½	2½	....
255½	155½	Eastman Kodak	172½	174	155½	167
33½	15½	Firestone Tire	19½	20½	16½	19
5½	1	Fisk Rubber	1½	1½	1	1½
55½	29½	Freeport Texas Sulphur	33½	34½	29½	32½
71½	28½	General Asphalt	30½	31½	28½	30
38	8	Glidden	....	10½	8	....
47½	29½	Gold Dust	33	35½	29½	34½
58½	15½	Goodrich Co.	17½	22½	16½	19½
85	55	Hercules Powder	....	60½	55	....
23	11½	Heyden Chemical	....	12½	12	....
7	4½	Imperial Chemical, Ltd	....	5	5	....
124	31	Industrial Rayon	45	62	45	....
8½	3½	Int. Ag. Chemical	....	4½	3½	3½
44½	16½	International Nickel	17½	20½	17	18½
31½	6½	International Paper, A	9	9	6½	....
45½	31	International Salt	37	36½	34½	37½
25	11	Kellogg, Spencer & Sons	....	12½	11	12½
6½	1½	Kelly-Springfield	2	2½	1½	2
11	3½	Lee Rubber & Tire	....	4½	3½	....
36	21	Lehn & Fink	26	27½	23	....
31½	10½	Libby-Owens	....	14½	10½	13½
81½	42	Liquid Carbonic	47½	51½	42	48½
37½	10½	McKesson & Robbins	12½	14	10½	....
51½	32½	Mathieson Alkali	33½	38½	32½	36½
63½	23	Monsanto Chemical	25½	29½	23½	....
39½	21½	National Distillers Products	22½	25½	21½	25½
189½	115	National Lead	120	127	115	....
91½	48	New Jersey Zinc	52½	54	48½	50½
42	15½	Newport Corp.	18	19½	15½	....
32	16½	Ohio Oil	20½	21½	16½	18½
60½	36½	Owens-Ill. Glass	37	47	37	....
44½	16½	Phillips Petroleum	21½	22	16½	18
59½	39	Pittsburgh Plate Glass	....	40	39	....
57½	36	Pratt & Lambert	41	41	39	....
78½	52½	Procter & Gamble	66	66½	56½	65½
27½	10½	Pure Oil	12½	12½	10½	....
85	59	Sherwin-Williams	....	62	59	....
34½	8	Silica Gel	10	11	8	....
32	11½	Sinclair Oil	13½	14½	11½	12½
42	10½	Skelly Oil	....	17½	10½	....
75	48½	Standard Oil, Cal.	51½	52½	48½	49
84½	49	Standard Oil, N. J.	53½	55½	49	52½
40½	24½	Standard Oil, N. Y.	26½	27	24½	25
70	47½	Sun Oil	53½	55	47½	....
10	4	Swan & Finch	....	....	....	....
34½	27½	Swift & Co.	28½	29½	27½	29½
17	8½	Tennessee Copper & Chemical	9	11	9	10½
60½	35	Texas Corporation	40½	40½	35	38½
67½	47½	Texas Gulf Sulphur	52½	53½	47½	53½
17½	7½	Tidewater Assoc. Oil	10	10	7½	7½
22½	3½	Tubize-Chatillon, B	....	7	4	6½
106½	54	Union Carbide	61½	64	54	61½
50	25½	Union Oil, Cal.	29	29½	25½	25½
84	23½	United Carbon	....	30½	23½	24½
139½	56½	U. S. Industrial Alcohol	63	71½	56½	68
15½	5½	U. S. Leather	....	6½	5½	....
35	11	U. S. Rubber	13½	17	11½	15
97½	59½	Vacuum Oil	61	66½	59½	63½
143½	44½	Vanadium Corp.	48½	59½	44½	53½
8½	2½	Va.-Car. Chemical	2½	3	2½	....
29½	22	Wesson Oil	24½	24½	23½	23½
59½	25	Westvaco Chlorine	....	28	25	26½
7½	2½	Wilson & Co.	....	3½	2½	....

ECONOMIC INFLUENCES

on production and consumption of CHEMICALS

Chemical Output Holds Above Level Of Industry in General

Gradual Improvement in Demand Expected In First Quarter of 1931

REPORTS of lessened activities in general industrial lines have been current in recent weeks and data available for such industries as steel and automobiles bear out the reports. Chemical production, while showing some letdown from the rate maintained in the immediate preceding months, does not appear to have fallen off to the same degree as is reported for industry in general. The movement of chemicals to consumers in November did not come up to expectations, but more recently there has been some revival in contract business, and while trading undoubtedly has been quickened at the cost of values, nevertheless the effect is shown in an increase in the advance sale of next year's production of chemicals.

Production and consumption of chemicals in October may be estimated to a certain degree by comparison with October last year from the following figures:

Production	Oct., 1930	Oct., 1929
Arsenic, crude, tons	2,694	3,113
Arsenic, refined, tons	1,265	1,036
Alcohol, ethyl, 1,000 pr. gal.	18,455	25,426
Withdrawn for denaturing, 1,000 pr. gal.	18,537	24,203
Automobiles:		
Passenger cars	112,209	318,462
Trucks, no.	37,244	60,687
Taxis, no.	591	868
Byproduct coke, 1,000 tons	3,432	4,605
Explosives, 1,000 lb.	34,113	42,108
Petroleum, refined, 1,000 bbl.	74,016	88,390
Rosin, wood, bbl.	34,818	40,903
Turpentine, wood, bbl.	5,817	7,640
Pine oil, gal.	225,688	259,017
Sugar, refined, meltings at eight ports, tons	402,333	380,758
Cottonseed oil, crude, 1,000 lb.	283,029	277,468
Cottonseed oil, refined, 1,000 lb.	232,179	210,636
Consumption		
Cotton, bales	444,494	639,759
Silk, bales	61,937	57,489
Wool, 1,000 lb.	40,975	59,352
Cottonseed oil, bbl.	379,500	386,100

Compared with activities in October last year, a decline is noted in most cases, but the comparison is more favorable when made with the preceding month of this year. One report of general conditions for October shows consumption of electrical power off 23 per cent, car loadings off 19 per cent, factory employment off 20 per cent, building contracts off 24 per cent, steel production off 40 per cent, and automobile output off 60 per cent, the comparison being with October, 1929.

Without more complete data than are now at hand it is impossible to fix definitely the percentage of decline in chemical output in the same comparable period. However, from information which has been made public, it is evident that the falling off is less than in the cases cited above.

With the holiday and inventory periods breaking into the coming month, chief interest rests in the prospects for the first quarter of the new year. Some uncertainty exists regarding what may be expected in the fertilizer trade. Sales of fertilizer tags in sixteen Southern states for the four months August-November were 81.6 per cent of those for the corresponding months of the previous year. It is probable that there will be a drop in fertilizer sales for the entire season, but it is not to be expected that this will be as much as 18 per cent, hence the rate of sales should be speeded up after the turn of the year.

Control over petroleum production already has shown results and there can be no doubt that chemical consumption in oil refining will be smaller in the first quarter of 1931 than it was in the first quarter of 1930.

The outlook for textile and tanning chemicals is brighter than it was a year ago. Window glass production in the coming three months should be considerably higher than last year, with favorable showings in other branches of the glass industry.

With building and automotive schedules listed to show marked increases, a more active market will exist for a diversified line of chemicals which enter those industries.

In short, a review of conditions in the lines which offer the largest outlets for chemicals, lends confidence in the belief that the coming quarter will witness a gradual growth in consumption.

ACCORDING to preliminary figures issued by the Bureau of Mines, the total production of benzol during the first three-quarters of this year amounts to 88,830,000 gal., a considerable drop from the corresponding 1929 figures of 96,894,000 gal. Exports of 39,002,000 gal. during the first three quarters of 1930 are well above the 23,288,000 gal. shipped abroad during the same period last year. Imports of 1,945,000 gal. during the first three-quarters of this year also represent an increase, as compared with the 1,690,000 gal. purchased from abroad during the corresponding period of 1929. During the period, Germany received 52 per cent of our exports and Canada contributed 97 per cent of our imports.

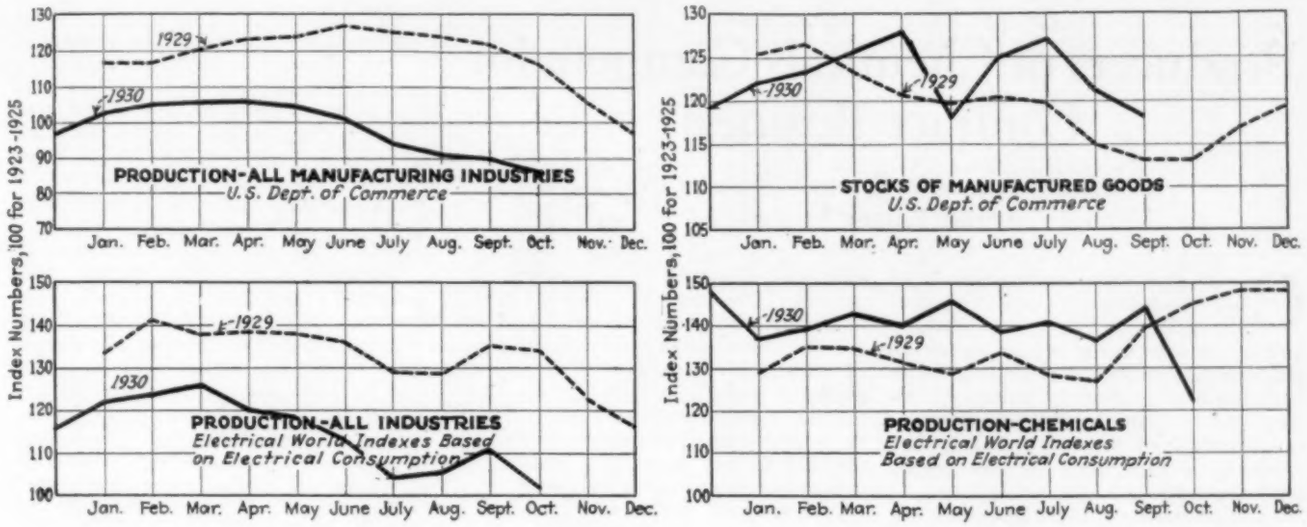
September production of refined methanol, according to the Bureau of the Census, aggregated 689,726 gal., of which 488,063 gal. was of synthetic origin. During the three-quarter period synthetic production totaled 4,353,914 gal., or 60 per cent of the total refined production. Stocks on hand at the end of September of refined synthetic methanol were 1,172,595 gal. and of wood-distillation origin, 20,346 gal.

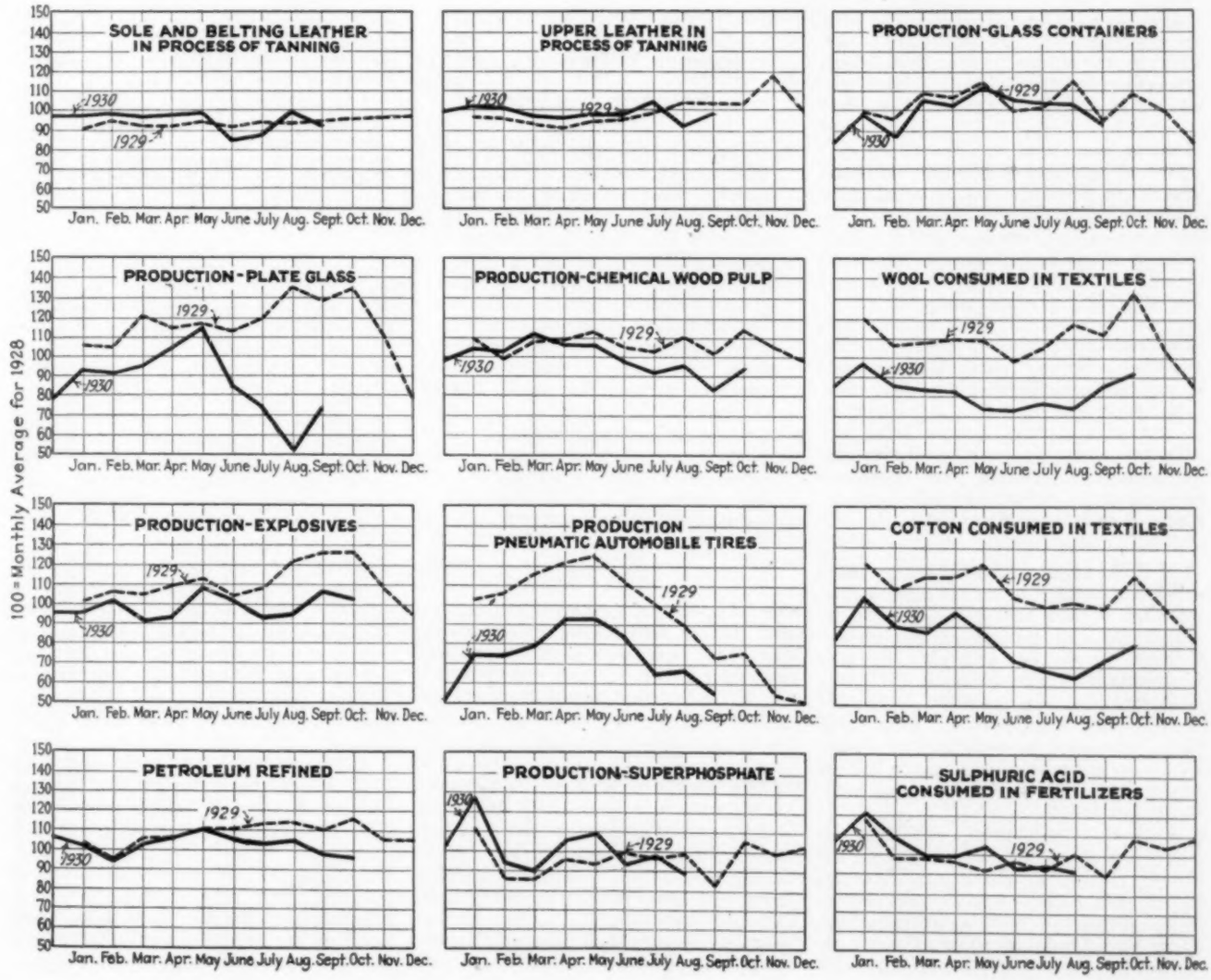
Nitrate of Soda Production Declines

A REPORT to the Department of Commerce states that a statistical review of the nitrate industry in Chile for the first ten months of 1930 shows that efforts designed to increase consumption have not led to the desired reduction of stocks of finished nitrate in Chile and world consuming markets.

Month	Plants in Operation 1929	Plants in Operation 1930	Production 1929 Metric Tons	Production 1930 Metric Tons	Exports 1929 Metric Tons	Exports 1930 Metric Tons	World Stocks 1929 Metric Tons	World Stocks 1930 Metric Tons
Jan.	68	66	274,519	277,478	439,686	234,937	2,193,542	2,732,040
Feb.	68	53	255,452	233,877	269,030	169,291	2,109,392	2,678,703
March	69	53	279,106	244,005	285,767	187,594	1,883,025	2,495,767
April	69	40	271,178	205,158	218,439	78,836	1,707,325	2,323,372
May	69	38	276,627	215,389	149,703	74,573	1,623,458	2,310,965
June	67	38	261,738	205,911	144,826	63,474	1,653,136	2,324,340
July	70	33	272,439	199,284	208,639	136,595	1,831,065	.....
Aug.	71	32	271,643	202,466	191,190	66,048	2,013,172	2,515,859
Sept.	70	32	252,238	181,467	251,999	79,139	2,127,972	2,627,555
Oct.	69	29	277,961	179,357	261,460	222,025	2,300,124	.....
Nov.	68	..	260,949	.....	249,042	.....	2,454,576	.....
Dec.	68	..	285,461	.....	228,033	.....	2,621,833	.....

ACTIVITY IN PRODUCING AND CONSUMING INDUSTRIES





MARKET CONDITIONS AND PRICE TRENDS

Producers of Chemicals Compete for Contract Business

Price Concessions Granted in Order to Attract Buying Interest

CONSUMERS of chemicals have been somewhat backward in placing orders for future requirements and as the contracting season advanced, producers have shown more activity in arousing buying interest. In many cases this activity has taken the form of price concessions and in some instances has resulted in reductions in the openly quoted prices.

Liquid chlorine is included among the chemicals for which selling competition has been keen. Starting with concessions from the $2.40 per 100 lb. basis, sellers have reached a point where they are offering at $2 per 100 lb. in tanks. This is an unusually low figure and, according to some reports, does not leave any margin of profit. Considerable business is said to have been placed at the reduced level.

Anhydrous ammonia also has been lowered in price and has received more attention from buyers. Domestic production of anhydrous ammonia for 1929 was placed at 86,819 tons. The rapid increase in output is shown by comparison with 1927, in which year only 22,558 tons was produced in this country. Export trade in anhydrous ammonia this year has averaged about 100 tons per month, and it is evident that the great bulk of production must find an outlet in domestic markets. With some uncertainty about the position of consuming trades in the coming year, producers have taken the initiative by offering contracts at more attractive prices.

METHANOL has attracted more than usual attention during the month. In the first place its use as anti-freeze was opposed on the ground that it would be a health menace. Government experts were asked to pass judgment on this question, and after considerable experimental work had been completed a report was issued which in general gave a clean bill of health to methanol when used for anti-freeze purposes.

With its consumptive field thus enlarged the prospects were favorable for a larger demand for methanol. However, the possible gain in one direction seems to be threatened with a decreased use in other quarters. The Bureau of Industrial Alcohol has issued an order modifying Formula No. 5 for denatured alcohol. The formula called for 4 gal. of methanol to every 100 gal. of alcohol and the modification calls for only 2 gal. of methanol. Shortage of denaturing grade of methanol is the reason given for the change, but the modification is to remain effective only over the remainder of this year. A few days ago it was announced that a new denaturant would be used. The new product is obtained from petroleum in the California fields. It is thoroughly acceptable as a denaturant and is not poisonous. It had been known for some time that this new denaturant had been developed but it is now stated that it will be made use of within the next two or three weeks, so evidently a regular source of supply is in sight.

THE status of the domestic salt-cake industry was a topic of discussion in the last two weeks because of a hearing before the Commissioner of the Customs Bureau. An anti-dumping order had been sought on the ground that last year considerable quantities of German salt cake had been sold in our markets at prices lower than those prevailing in the markets of the country of origin. Domestic consumers, especially makers of kraft paper, testified that there had been no dumping and stated that domestic supplies of salt cake were not sufficiently large to take care of home requirements. The hearing served to focus attention on the rapid increase in imports of salt cake in the last two years.

Incidentally a recent report from Germany says that plans have been made by the Kaiseroda works of the Wintershall potash concern to increase daily production of salt cake from 500 tons to 600 tons. Up to the present, Kaiseroda has accounted for about one-half of German salt cake production. It also was announced that production of natural salt cake has just been started in Arizona. This makes two producers of natural cake in this country.

Producers and consumers of hydrofluoric acid were interested in a decision rendered by the Interstate Commerce Commission. The decision authorized shipment of anhydrous hydrofluoric acid in tank cars.

The Commission says that anhydrous hydrofluoric acid is a product not heretofore manufactured or offered for transportation and that it came under investigation in connection with a manufacturing process in which the acid is to be used.

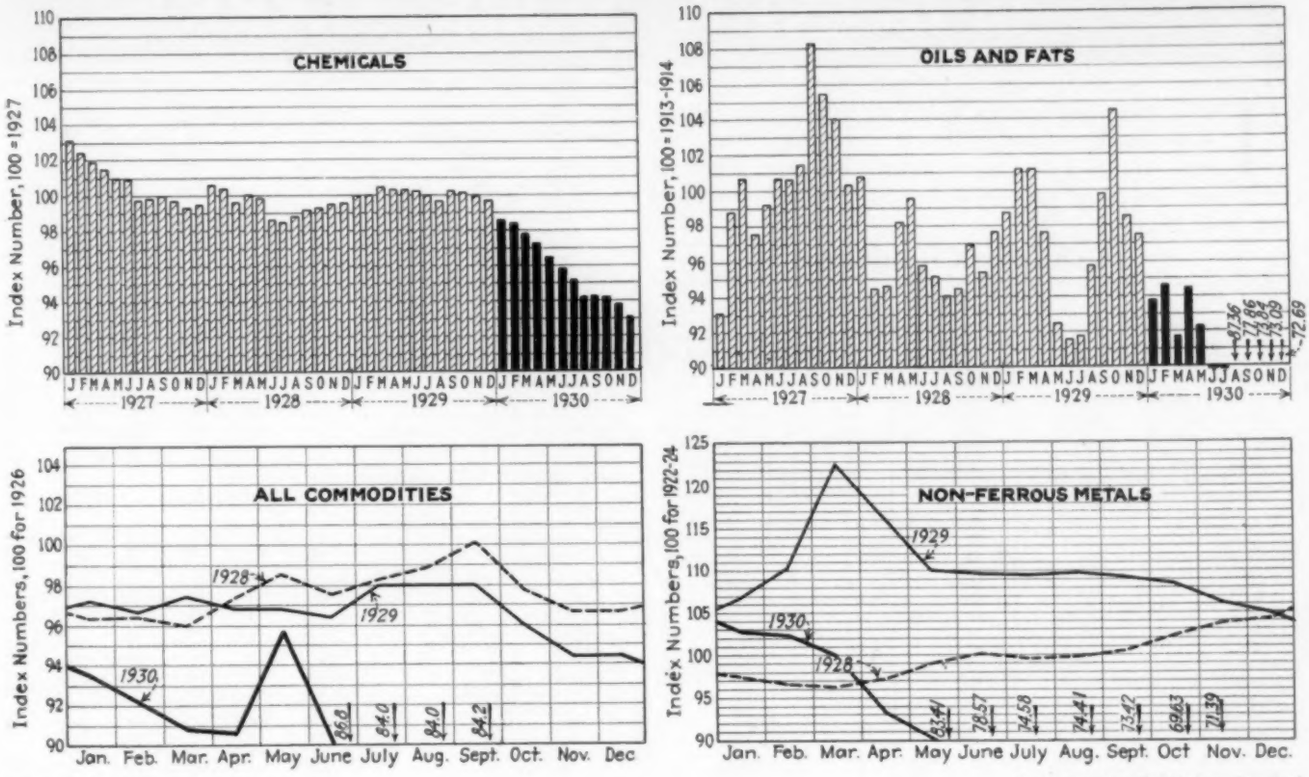
EXPORTERS of alkalis are interested in a report from Kobe which states that although Japanese producers of soda ash receive a subsidy of 6 yen a ton and an additional import duty of 6 yen is already placed on soda ash, they are asking the Japanese government to increase the present duty because of the keen competition from abroad. The glass manufacturers and the cotton textile exporters registered an energetic protest against an increase of the import duty. The Japanese manufacturers supplied one-half of the country's requirements of 120,000 metric tons in 1929, and it is expected that by 1933 Japan will be self-sustaining as regards soda ash. Requirements for 1930 are estimated at 100,000 tons. In 1929 the imports were 56,525 tons and for the first six months of 1930 were 26,295 tons.

Other developments in foreign markets include the announcement that the Camera Agrumaria, which controls the Sicilian output of citrate of lime, has established a price for the 1930-1931 season of 400 lire per quintal of 64 per cent citric acid content. It also is reported that the German tartaric acid combine has been dissolved after several years of successful operation.

Export Shipments of Sulphur Decline

Exports of crude sulphur for the first ten months of 1930 were 533,000 tons, valued at $11,063,-300, compared with 737,000 tons, valued at $15,000,000, for the same period of the preceding year. There is a sharp decline in the exports to France from 117,000 tons to 40,000 tons. Although there is a general decline in the demand from the large markets, the smaller markets increased their demand. The exports of crushed, ground, refined, and sublimed sulphur for the corresponding period were 16,000 tons, valued at $485,-380, compared with 15,000 tons, valued at $508,100, for 1928.

CHEM. & MET. *Weighted Indexes of* PRICES



U. S. Department of Labor — *Engineering & Mining Journal*

Chemical Prices Follow Irregular Trend of Trading

PRICE levels for chemicals were again lower during the last month. The buying trend has been irregular and this accounts in large measure for the course of values. Consumers have been slow to place commitments for requirements over next year and producers in attempting to stimulate buying interest have maintained a competitive market, with the result that contract prices for many chemicals were lowered below the figures quoted in the preceding month. Uncertainty regarding the prospects for the coming year undoubtedly has held back contract buying, but the reluctance of buyers also has been strengthened by the unstable price position of the market.

As far as fundamental conditions are concerned, last month brought forth no new conditions which might be interpreted as price factors. However, the fact that producers are now offering many chemicals at close to production costs should give greater confidence in the stability of prices.

Prospects relative to the first quarter of next year as compared with the final quarter of this year are regarded as favorable to a larger consumption of chemicals in the 1931 period. If these prospects eventuate a firmer price tone should follow as a result of the more active trading movement.

Referring to basic raw materials, it is found that the index number for non-ferrous metals, which had declined steadily throughout the year, turned upward in November. With curtailment of production in effect the upward swing to prices may continue, with the metal salts showing a corresponding reaction.

Reduced to simple terms, the history of chemical prices this year only emphasizes the importance of the law of supply and demand. With demand reduced, selling pressure and declining values follow. Experience proves that the recovery of prices is not so rapid as the decline. Based on that theory, it will take more than a year to recover from the present level, represented by the index number 93.17, to the level of last January, represented by the index number 98.57.

The weighted index number for vegetable oils and fats closed at the lowest level of the year. Supplies have been ample at all times and buying interest has been of moderate proportions. As a group, oils and fats offer considerable competition and soap makers in particular are in a position to take advantage of this interchangeability. Hence weakness in one selection has a wide influence in the entire market. Of late, all oils and fats have maintained low sales prices, with large stocks to be worked off before any radical change is to be expected.

Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1927

This month	**93.17**
Last month	93.82
December, 1929	99.73
December, 1928	99.58

Sharp declines in prices for liquid chlorine and ammonia together with reductions in acetic acid, formaldehyde, and white lead brought a further decline in the weighted index number. An unsettled price tone ruled on different selections especially for distant delivery.

Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1927

This month	**72.69**
Last month	73.09
December, 1929	97.52
December, 1928	97.67

Animal fats sold at lower average levels than in the preceding month. Cotton oil closed fractionally lower with linseed oil subject to private negotiation. Crude menhaden oil was nominal at the close.

CURRENT PRICES *in the* NEW YORK MARKET

THE following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to Dec. 13.

Industrial Chemicals

	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.11 -$0.12	$0 11 -$0 12	$0 11 -$0.12
Acid, acetic, 28%, bbl., cwt.	2.60 - 2.85	2 73 - 2 88	3.88 - 4 03
Glacial 99%, tanks	8 98	8.98	
drs.	9.23 - 9.48	9 23 - 9.48	
U. S. P. reagent, c'bys.	9.73 - 9.98	9.73 - 9.98	
Boric, bbl, lb.	.06½- .07	06½ - .07	.06½- .07
Citric, kegs, lb.	.43½- .45	46 - .47	46 - .47
Formic, bbl, lb.	.10 - .11	.10 - .11	.10½- .11
Gallic, tech., bbl., lb.	.50 - .55	.50 - .55	.50 - .55
Hydrofluoric 30% carb, lb.	.06 - .07	.06 - .07	.06 - .07
Lactic, 44%, tech., light, bbl., lb.	.11½- .12	.11½ - .12	.11½- .12
22%, tech., light, bbl., lb.	.05½- .06	.05½ - .06	.05½- .06
Muriatic, 18°, tanks, cwt.	1.00 - 1.10½	1.00 - 1.10	1 00 - 1.10
Nitric, 36°, carboys, lb.	.05 - .05½	.05 - .05½	05 - .05½
Oleum, tanks, wks., ton	18.50 -20.00	18.50 -	18 50- 20 00
Oxalic, crystals, bbl., lb.	.11 - .11½	.11 - .11½	.11 - .11½
Phosphoric, tech., c'bys., lb.	.08½- .09	.08½- .09	.08½- .09
Sulphuric, 60°, tanks, ton	11 00 -11 50	11.00 -11 50	11.00 -11.50
Tannic, tech., bbl., lb.	.35 - .40	.35 - .40	.35 - .40
Tartaric, powd., bbl., lb.	.31 - .33	.33 - .34	.38 - .39
Tungstic, bbl., lb.	1.40 - 1.50	1 40 - 1 50	1 30 - 1 40
Alcohol, ethyl, 190 p'f., bbl., gal.	2.63 -	2.63 - 2.71	2.68½- 2.71
Alcohol, Butyl, tanks, lb.	.16½- .17	.16½- .17	.16½- .17
Alcohol, Amyl			
From Pentane, tanks, lb.	.236-	.236-	
Denatured, 188 proof			
No. 1 special dr., gal.	.40 -	.40 -	.52 -
No. 5, 188 proof, dr., gal.	.40 -	.40 -	.52 -
Alum, ammonia, lump, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Chrome, bbl., lb.	.05 - .05½	.05½- .05½	.05½- .06
Potash, lump, bbl., lb.	.03½- .04	.03 - .03½	.02½- .03½
Aluminum sulphate, com., bags, cwt.	1.40 - 1.45	1.40 - 1.45	1.40 - 1 45
Iron free, bg., cwt.	1.90 - 2.00	1.90 - 2.00	2.00 - 2 10
Aqua ammonia, 26°, drums., lb.	03 - .04	.03 - .04	.03 - 04
tanks, lb.	.02½- .02¾	.02½- .02¾	
Ammonia, anhydrous, cyl., lb.	.14 - .14½	.15½-	.15 -
tanks, lb.	.05¾-	.05¾-	
Ammonium carbonate, powd. tech., casks, lb.	.10½- .11	.10½- .11	.11 - .12
Sulphate, wks., cwt.	1.75 -	1.75 -	2.10 -
Amylacetate tech., tanks, lb., gal.	.222-	2 22 -	
Antimony Oxide, bbl., lb.	.08½- .10	.08½- .10	.09 - .10
Arsenic, white, powd., bbl., lb.	.04 - .04½	.04 - .04½	.04 - .04½
Red, powd., kegs., lb.	.09 - .10	.09 - .10	.09 - .10
Barium carbonate, bbl., ton	58 00 -60 00	58 00 -60 00	58.00 -60.00
Chloride, bbl., ton	63 00 -65 00	63.00 -65.00	64 00 -70.00
Nitrate, cask, lb.	.07 - .07½	.07 - .07½	.08 - .08½
Blanc fixe, dry, bbl., lb.	.03½- .04	.03½- .04	.04 - .04½
Bleaching powder, f.o.b., wks., drums, cwt.	2.00 - 2.10	2.00 - 2.10	2.00 - 2.10
Borax, bbl., lb.	.033- .033	.033- .033	.02½- .03
Bromine, cs., lb.	.45 - .47	.45 - .47	.45 - .47
Calcium acetate, bags	2.00 -	2.00 -	4 50 -
Arsenate, dr., lb	.07 - .08	.07 - .10	.06½- .07
Carbide drums, lb.	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., wks., ton	20 00 -	20 00 -	20 00 -
flake, dr., wks., ton	22.75 -	22.75 -	22.75 -
Phosphate, bbl., lb.	.08 - .08½	.08 - .08½	.07 - .07½
Carbon bisulphide, drums, lb.	.05 - .06	.05½- .06	.05 - .06
Tetrachloride drums, lb.	.06½- .07	.06½- .07	.06½- .07
Chlorine, liquid, tanks, wks., lb.	.02 -	.024-	.02½-
Cylinders	.04 - .06	.04 - .06	.05 - .08
Cobalt oxide, cans, lb.	2 10 - 2 20	2 10 - 2.20	2.10 - 2 25
Copperas, bgs., f.o.b. wks., ton	13.00 -14.00	13.00 -14.00	15 00 -16.00
Copper carbonate, bbl., lb.	08½ - 18	08½ - 17	.22 - .23
Cyanide, tech., bbl., lb.	41 - 46	41 - 46	49 - 50
Sulphate, bbl., cwt.	4.25 - 4.50	3 95 - 4 25	5.50 - 6.00
Cream of tartar, bbl., lb.	24½ - 26	.24½- .26	.27½- .28
Diethylene glycol, dr., lb.	14 - 16	.14 - .16	.10 - .15
Epsom salt, dom., tech., bbl., cwt.	1 75 - 2 15	1.75 - 2.00	1.75 - 2.00
Imp., tech., bags, cwt.	1.15 - 1 25	1.15 - 1.25	1.15 - 1 25
Ethyl acetate, drums, lb.	.094-	.094-	.125-
Formaldehyde, 40%, bbl., lb.	06 - .07	.07½- .08	.08½- .09
Furfural, dr., contract, lb.	10 - .12	.10 - .12	.15 - .17
Fusel oil, crude, drums, gal.	1 30 - 1 40	1 30 - 1.40	1.30 - 1 40
Refined, dr., gal.	1 90 - 2.00	1.90 - 2.00	2.50 - 3.00
Glaubers salt, bags, cwt.	1 10 - 1 20	1.10 - 1.20	1 00 - 1.10
Glycerine, c.p., drums, extra., lb.	.13 - 13½	.13 - .13½	.14 - .15
Lead:			
White, basic carbonate, dry casks, lb.	07½-	07½-	.09 -
White, basic sulphate, sck., lb.	07 -	07½-	.08½-
Red, dry, sck., lb.	.08½-	08½-	.09½-
Lead acetate, white crys., bbl., lb.	11½- 12	11½- .12	.13 - .13½
Lead arsenate, powd., bbl., lb.	13 - .14	.13 - .14	.13 - .14
Lime, chem., bulk, ton	8 50 -	8.50 -	8.50 -
Litharge, pwd., csk, lb.	07½-	07½-	.08½-
Lithopone, bags, lb.	05½- .06	.05½- .06	.05½- .06½
Magnesium carb., tech., bags, lb.	06 - .06½	.06 - .06½	.06½- .07
Methanol, 95%, tanks, gal.	.38 -	.38 -	.48 -
97%, tanks, gal.	39 -	.39 -	.50 -
Synthetic, tanks, gal.	.40½- .45	.40½-	
anti-freeze, 76½%, tanks, gal.	.31	.31 -	
Nickel salt, double, bbl., lb.	.13 - 13½	.13 - .13½	.13 - .13½
Single, bbl., lb.	.13 - .13½	.13 - .13½	.13 - .13½
Orange mineral, csk., lb	.10½-	.10½-	.11½-
Phosphorus, red, cases, lb.	.42 - .44	.42 - .44	.55 - .57
Yellow, cases, lb.	.31 - .32	.31 - .32	.32 - .33
Potassium bichromate, casks, lb	.09 - .09½	.09 - .09½	.09 - .09½
Carbonate, 80-85%, calc., csk., lb	.05½- .06	.05½- .06	.05½- .06
Chlorate, powd., lb.	.08½- .09	.08½- .09	.07½- .08½
Cyanide, cs., lb.	.55 - .57	.55 - .57	51 - .53
First sorts, csk., lb.	.08½- .09	.08½- .09	.08½- .09
Hydroxide (c'stic potash) dr., lb	.06½- .06¾	.06½- .06½	.06½- .06¾
Muriate, 80% bgs., ton	37.15 -	37.15 -	36.75 -
Nitrate, bbl., lb.	.06 - .06½	.06 - .06½	.06 - .07½
Permanganate, drums, lb.	.16 - .16½	.16 - .16½	.16 - .16½
Prussiate, yellow, casks, lb.	.18½- .19	.18½- .19	.19 - .19½
Sal ammoniac, white, casks, lb	.046- .05	.046- .05	.047- .05
Salsoda, bbl., cwt.	90 - .95	.90 - .95	.90 - .95
Salt cake, bulk, ton	15.00 -18.00	15.00 -18.00	22.00 -25.00
Soda ash, light, 58%, bags, contract, cwt.	1.32 -	1.32 -	1.32 -
Dense, bags, cwt.	1.35 -	1.35 -	1.35 -
Soda, caustic, 76%, solid, drums, contract, cwt.	2.90 - 3.00	2.90 - 3.00	2.90 - 3.00
Acetate, works, bbl., lb.	.04½- .05	.04 - .05	.05 - .05½
Bicarbonate, bbl., cwt.	2.00 - 2 25	2.00 - 2.25	2.00 - 2.25
Bichromate, casks, lb.	.07 - .07½	.07 - .07½	.07 - .07½
Bisulphate, bulk, ton	14 00 -16 00	14.00 -16.00	12.00 -15.00
Bisulphite, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Chlorate, kegs, lb	.05½- .07½	.07½- .08	.06½- .06½
Chloride, tech., ton	12.00 -14.75	12.00- 14.75	12.00 -14.00
Cyanide, cases, dom., lb.	.17 - .18	.18 - .22	.18 - .22
Fluoride, bbl., lb.	.08½- .09	.08½- .09	.08½- .09
Hyposulphite, bbl., lb.	2.40 - 2.50	2 40 - 2.50	2.50 - 3.00
Nitrate, bags, cwt.	2.02 -	2.02 -	2.10 -
Nitrite, casks, lb.	.07½- .08	.07½- .08	.07½- .08
Phosphate, dibasic, bbl., lb.	.03 - .03½	.03 - .03½	.03½- .03¾
Prussiate, yel. drums, lb	.11½- .12	.11½- .12	.11½- .12
Silicate (30°, drums), cwt.	.60 - .70	.60 - .70	.75 - 1.15
Sulphide, fused, 60-62%, dr., lb.	.02½- .03	.02½- .03	.03½- .04
Sulphite, cyrs., bbl., lb.	03 - .03½	03 - .03½	.02½- .03
Sulphur, crude at mine, bulk, ton	18 00 -	18.00 -	18.00 -
Chloride, dr., lb.	05 - .06	.04 - .05	.04 - .05
Dioxide, cyl., lb.	06½- .07	.07 - .08	.09 - .10
Flour, bag, cwt.	1.55 - 3.00	1 55 - 3.00	1.55 - 3.00
Tin bichloride, bbl., lb.	nom. -	nom. -	.14½-
Oxide, bbl., lb.	.30 -	.34 -	.42 -
Crystals, bbl., lb	.25 - .26	.25½-	.32½-
Zinc chloride, gran., bbl., lb.	.06½- .06¾	.06½- .06¾	.06½- .06¾
Carbonate, bbl., lb.	.10½- .11	.10½- .11	.10 - .11
Cyanide, dr., lb.	.41 - .42	.40 - .41	.40 - .41
Dust, bbl., lb.	.07½- .08	.07½- .08	.09 - .10
Zinc oxide, lead free, bag, lb.	.06½-	.06½-	.06½-
5% lead sulphate, bags, lb.	.06½-	.06½-	.06½-
Sulphate, bbl., cwt.	3 00 - 3.25	2 75 - 3.00	2.75 - 3.00

Oils and Fats

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.11½-$0.12½	$0.11½-$0.12½	$0.12½-$0.13
Chinawood oil, bbl., lb.	.07 -	.07 -	.14½-
Coconut oil, Ceylon, tanks, N.Y., lb.	.05½-	.05½-	.07 -
Corn oil crude, tanks, (f.o.b. mill), lb.	.07½-	07½-	.08 -
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.06¾-	.06¾-	.07½-
Linseed oil, raw, car lots, bbl., lb.	.094-	.094-	.149-
Palm, Lagos, casks, lb.	.06½-	.05½-	.07 -
Niger, casks, lb.	.06½-	.05½-	.06¾-
Palm Kernel, bbl., lb.	.06½-	.06½-	.07¾-
Peanut oil, crude, tanks (mill), lb	.07 -	.07 -	.08½-
Rapeseed oil, refined, bbl., gal.	.54 - .56	.55 - .58	.78 - 80
Soya bean, tank (f.o.b. Coast), lb.	.06½-	.08½-	.09½-
Sulphur (olive foots), bbl., lb.	.06½-	.06 -	.08½-
Cod, Newfoundland, bbl., gal.	.50 - .52	.53 - 55	.65 - .67
Menhaden, light pressed, bbl., gal.	.40 - .42	.47 - .49	.70 - .72
Crude, tanks (f.o.b. factory), gal.	.20 -	.20 -	.43 -
Whale, crude, tanks, gal.	.78 -	.78 -	- .80
Grease, yellow, loose, lb.	.04½-	.04½-	.06½-
Oleo stearine, lb.	.08½-	.08½-	.11½-
Red oil, distilled, d.p. bbl., lb.	.08½-	.08¾-	.09½- .09¾
Tallow, extra, loose, lb.	.04½-	.04¾-	.07¾-

Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl., lb.	.80 - .85	.80 - .85	.85 - .90
Alpha-naphthylamine, bbl., lb.	.32 - .34	.32 - .34	.35 - .36
Aniline oil, drums, extra, lb.	.15 - .15½	.15 - .15½	.15 - .16
Aniline salts, bbl., lb.	.24 - .25	.24 - .25	.24 - .25
Anthracene, 80%, drums, lb.	.60 - .65	.60 - .65	.60 - .65

Coal-Tar Products (Continued)

	Current Price	Last Month	Last Year
Benzaldehyde, U.S.P., dr., lb.	1.15 - 1.25	1.15 - 1.35	1.15 - 1.25
Benzidine base, bbl., lb.	.65 - .67	.65 - .67	.65 - .67
Benzoic acid, U.S.P., kgs, lb.	.57 - .60	.57 - .60	.57 - .60
Benzyl chloride, tech., dr., lb.	.30 - .35	.25 - .26	.25 - .26
Benzol, 90%, tanks, works, gal.	.21 - .23	.21 - .23	.23 - .24
Beta-naphthol, tech., drums, lb.	.22 - .24	.22 - .24	.22 - .24
Cresol, U.S.P., dr., lb.	.14 - .17	.14 - .17	.14 - .17
Cresylic acid, 97%, dr., wks., gal.	.58 - .61	.60 - .70	.67 - .70
Diethylaniline, dr., lb.	.55 - .58	.55 - .58	.55 - .58
Dinitrophenol, bbl., lb.	.29 - .30	.30 - .31	.31 - .35
Dinitrotoleun, bbl., lb.	.16 - .17	.16 - .17	.17 - .18
Dip oil, 25% dr., gal.	.26 - .28	.26 - .28	.28 - .30
Diphenylamine, bbl., lb.	.38 - .40	.39 - .40	.45 - .47
H-acid, bbl., lb.	.68 - .70	.68 - .70	.63 - .65
Naphthalene, flake, bbl., lb.	.03½ - .04½	.04½ - .05	.05 - .06
Nitrobenzene, dr., lb.	.08½ - .09	.08½ - .09	.08¼ - .10
Para-nitraniline, bbl., lb.	.51 - .55	.51 - .55	.52 - .53
Para-nitrotoluine, bbl., lb.	.29 - .30	.29 - .31	.28 - .32
Phenol, U.S.P., drums, lb.	.14½ - .15	.14½ - .15	.14½ - .15
Picric acid, bbl., lb.	.30 - .40	.30 - .40	.30 - .40
Pyridine, dr., lb.	1.75 - 1.90	1.50 - 1.80	1.75 - 1.90
R-salt, bbl., lb.	.40 - .44	.44 - .45	.44 - .45
Resorcinal, tech., kegs, lb.	1.15 - 1.25	1.15 - 1.25	1.30 - 1.40
Salicylic acid, tech., bbl., lb.	.33 - .35	.33 - .35	.30 - .32
Solvent naphtha, w.w., tanks, gal	.25 - .30	.28 -	.35 - .....
Tolidine, bbl., lb.	.88 - .90	.91 - .93	.95 - .96
Toluene, tanks, works, gal.	.30 -	.35 -	.35 - .....
Xylene, com., tanks, gal.	.25 - .28	.25 - .28	.36 - .40

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton.	$23.00-$25.00	$23.00-$25.00	$23.00-$25.00
Casein, tech., bbl., lb.	.10½ - .12	.10½ - .12	.15½ - .16
China clay, dom., f.o.b. mine, ton	8.00 -20.00	8.00 -20.00	10.00 -20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.04 - .22	.05 - .22	.06½ - .07
Prussian blue, bbl., lb.	.35 - .36	.35 - .36	.31 - .32
Ultramine blue, bbl., lb.	.06 - .32	.06 - .32	.03 - .35
Chrome green, bbl., lb.	.27 - .28	.27 - 28	.27 - .30
Carmine red, tins, lb.	6.00 - 6.50	6 00 - 6 50	5.25 - 5.50
Para toner, lb.	.77 - .80	.77 - 80	.70 - .80
Vermilion, English, bbl., lb.	1 75 - 1.90	1 75 - 1 90	1.80 - 1.85
Chrome yellow, C. P., bbl., lb.	16½ - .17	.17 - 17½	.15½ - .16
Feldspar, No. 1 (f.o.b. N.C.), ton	6 50 - 7.50	6 50 - 7 50	5.75 - 7.00
Graphite, Ceylon, lump, bbl., lb.	.07 - .08½	.04 - .05	.08 - .09
Cum copal Congo, bags, lb.	.07 - .09	.07 - .08	.07½ - .08
Manila, bags, lb.	.16 - .17	.16 - .17	.15 - 18
Damar, Batavia, cases, lb.	.16 - .16½	.16 - .19	.22 - .23
Kauri No. 1 cases, lb.	.48 - .50	.48 - 53	.48 - 53
Kieselguhr (f.o.b. N. Y.), lb.	50.00 -55.00	50.00 -55.00	50.00 -55 00
Magnesite, calc, ton	40.00 -.....	40.00 -.....	40.00 -.....
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb.	.03 - .40	.03 - .40	.03 - .35
Rosin, H., bbl.	5.55 -.....	5 50 -.....	8.60 -.....
Turpentine, gal.	.41 -	.41 -.....	.54 -.....
Shellac, orange, fine, bags, lb.	.42 - .43	.43 - .44	.58 - .60
Bleached, bonedry, bags, lb.	.28 - .30	.28 - .30	.52 - .54
T. N. bags, lb.	.19 - .21	.19 - .21	.35 - .36
Soapstone (f.o.b. Vt.), bags, ton	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	9.50 -.....	9.50 -.....	10.50 -.....
300 mesh (f.o.b. Ga.), ton	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N. Y.), ton.	13.75 -.....	13.75 -.....	13 75 -... 1

	Current Price	Last Month	Last Year
Wax, Bayberry, bbl., lb.	$0.22 -$0.24	$0 21 -$0.24	$0.28 -$0 30
Beeswax, ref., light, lb.	.33 - .35	.34 - .36	.38 - 39
Candelilla, bags, lb.	.16 - .18	.15½ - .16	.21 - .22
Carnauba, No. 1, bags, lb.	.26 - .27	.27 - .28	.35 - .36
Paraffine, crude 105-110 m.p., lb.	.04 - .04½	.04 - .05	.04½ - .05

Ferro-Alloys

	Current Price	Last Month	Last Year
Ferrotitanium, 15-18%, ton.	$200.00	$200.00-.....	$200.00-.....
Ferromanganese, 78-82%, ton.	94.00 99 00	94.00-99.00	100 00-.....
Spiegeleisen, 19-21%, ton.	33 00	33.00-.....	33 00-.....
Ferrosilicon, 14-17%, ton.	39 00	39.00-.....	45.00-.....
Ferrotungsten, 70-80%, lb.	1.10.....	1.10-.....	1.45-.....
Ferro-uranium, 35-50%, lb.	4.50-.....	4.50-.....	4.50-.....
Ferrovanadium, 30-40%, lb.	3.15- 3.50	3.15- 3.75	3.15- 3.75

Non-Ferrous Metals

	Current Price	Last Month	Last Year
Copper, electrolytic, lb.	$0.10¾	$0.10 -.....	$0.18 -.....
Aluminum, 96-99%, lb.	.233-.....	.233-.....	.24 - 25
Antimony, Chin. and Jap., lb.	0705-.....	.07 -.....	.08½ - .09
Nickel, 99%, lb.	.35 -.....	.35 -.....	.35 -.....
Monel metal, blocks, lb.	.28 -.....	.28 -.....	.28 -.....
Tin, 5-ton lots, Straits, lb.	.251-.....	.25 -.....	.41½-.....
Lead, New York, spot, lb.	5 10 -.....	5 10 -.....	.0625-.....
Zinc, New York, spot, lb.	.045 -.....	.0465	.06 -.....
Silver, commercial, oz.	.33½-.....	.35¼-.....	.49½-.....
Cadmium, lb.	.70 - .75	.70 - .75	.85 - .95
Bismuth, ton lots, lb.	1.00 -	1.00 -.....	1.70 -...
Cobalt, lb.	2.50 -	2.50 - 2.50	2 50 -...
Magnesium, ingots, 99%, lb.	48 -.....	.65 - 1.00	.85 - 1.10
Platinum, ref., oz.	36 00-.....	36 00-.....	65 00 66.00
Palladium ref., oz.	22.00- 23.00	22.00- 23.00	35.00-36.00
Mercury, flask, 75 lb.	105 00-107.00	106.00-108.00	124.00-.....
Tungsten powder, lb.	1 55- 1 60	1.55- 1.60	1.35 1.50

Ores and Semi-finished Products

	Current Price	Last Month	Last Year
Bauxite, crushed, wks., ton.	$6.50- $8.25	$7.50- $8.50	$5 50- $8 75
Chrome ore, c.f. post, ton.	19 50- 24 00	19 50- 24.00	22 00- 23 00
Coke, fdry., f.o.b. ovens, ton.	2 75- 2 85	2 75- 3 85	2 85- 3 00
Fluorspar, gravel, f.o.b. Ill., ton.	17 25- 20.00	18.00- 20.00	18 00- 20.00
Manganese ore, 50% Mn., c.i.f. Atlantic Ports, unit.	.31 - .36	.31 - .36	.36 - .38
Molybdenite, 85% MoS_2 per lb. MoS_2, N. Y., lb.	.33 - .35	.33 - .35	.48- .50
Monazite, 6% of ThO_2, ton.	60.00 -.....	60.00 -.....	60.00-....
Pyrites, Span. fines, c.i.f., unit.	.13 -.....	.13 -.....	.13 -.....
Rutile, 94-96% TiO_2, lb.	.10 - .11	.10 - .11	.11 - .13
Tungsten, scheelite, 60% WO_2 and over, unit.	12 25 - 13.50	12 25 -13.50	11.25 -11 50

CURRENT INDUSTRIAL DEVELOPMENTS

New Construction and Machinery Requirements

Brick and Tile Plant — Reagan Brick Co., Hales Bldg., Oklahoma City, Okla., had plans prepared for the construction of a brick and tile plant at 64th St. and Oklahoma Railway. Estimated cost $250,000. Private plans. Work will be done by day labor.

Cement Manufacturing Plant Addition—Lone Star Cement Co., 342 Madison Ave., New York, N. Y., plans expansion to cement manufacturing plant at Houston, Tex. Estimated cost $80,000. Maturity about Jan. 1. Machinery and equipment will be required (after Jan. 1).

Cement Storage Silos—Davison Coke & Iron Co., Neville Island, Pa., awarded contract for superstructure of six cement storage silos, 80 ft. high and 35 ft. in diameter to Rust Construction Co., Koppers Bldg., Pittsburgh, $58,948.

Chemical Plant—E. I. Du Pont de Nemours & Co., Wilmington, Del., had plans prepared for additions and alterations to chemical plant at Mineral Springs, Ala. Estimated cost to exceed $100,000. Work will be done by day labor and separate contracts.

Chemical Plant — Mallinckrodt Chemical Works, West Side Ave., Jersey City, N. J., will soon award contract for the construction of a 2 story, 75 x 155 ft. chemical plant. Estimated cost $40,000. H. W. Andrews, 15 East 40th St., New York, N. Y., is architect and engineer.

Chemical Plant — Virginia-Carolina Chemical Co., Richmond, Va., awarded contract for the construction of a warehouse and storage building at Memphis, Tenn., also at Jackson, Miss., to Meers & Wallenka, 63 South 3rd St., Memphis, Tenn. Estimated cost $40,000 each.

Clay Plant — American Art Clay Co., 4717 West 16th St., Indianapolis, Ind., will build a clay factory. Estimated cost $40,000. Private plans. Work will be done by separate contracts.

Dextrine Plant—National Adhesive Corp., A. Alexander, Pres., 705 West Front St., Plainfield, N. J., plans a 2 story addition to dextrine plant on West St. Estimated cost $40,000. Architect not announced.

Drug Factory — Owner, c/o C. E. Wunder, Architects Bldg., Philadelphia, Pa., Archt., awarded contract for the construction of a 4 story, 31 x 51 and 18 x 31 ft. drug factory on North 5th St. to Cramp Co., Denckla Bldg., Philadelphia. Smith Kline & French Co., 105 North 5th St., Philadelphia, are lessees.

Enameling Plant—National Stove Works, subsidiary of American Stove Co., J. R. Haley, Plant Mgr., Lorain, O., plans the construction of a 1 story, 125 x 125 ft. enameling plant. Estimated cost $250,000. Carter-Richards Co., Engineers Bldg., Cleveland, are architects and engineers.

Fertilizer Plant—Smith Agricultural Chemical Co., 1850 Kentucky Ave., Indianapolis, Ind., awarded contract for the construction of a fertilizer plant to Hall Construction Co., 500 Bd. of Trade Bldg., Indianapolis. Estimated cost $40,000.

Gas Plant—Dept. of Public Utilities, G. H. Whitfield, Dir., Richmond, Va., plans extensions and improvements to gas plant. Estimated cost $500,000.

Gas Plant—Empire Gas Co., W. W. Smith, Res. Engr., Beatrice, Neb., awarded contract for the construction of a gas plant to Siedhoff Construction Co., Broadview Hotel, Wichita, Kan. Estimated cost $530,000.

Gas Plant—Skelly Oil Co., El Dorado, Kan., will build a Butane-air gas plant and distribution system including two 10,000 gal. tanks, storage in two 10 x 40 ft. tanks, two 7,000 cu.ft. per hr. compressor units each driven by two 10 hp. motors, etc. at Spencer, Ia. Private plans. Work will be done by day labor under the supervision of W. G. Watkins, Company Engr.

Gas Compressor Plant, etc. — Manufacturers Natural Gas Co. Ltd., Hamilton, Ont., is having plans prepared for the construction of a gas compressor plant, purification plant, 1,000,000 ft. gas holder and gas mains at Burlington, Sherman and Barton Sts. Estimated cost $1,000,000.

Plant—Prest-O-Lite Co., subsidiary of Union Carbide & Carbon Co., 30 East 42nd St., New York, N. Y., plans the construction of a plant at Chicago, Ill. Estimated cost to exceed $100,000. Private plans. Maturity in spring.

Glass Manufacturing Plant—Pittsburgh Plate Glass Co., Grand Bldg., Pittsburgh, Pa., is having preliminary surveys made for the construction of a sheet glass manufacturing plant at Santa Ana, Calif. Estimated cost to exceed $1,000,000. Stone & Webster Engineering Co., 120 Broadway, New York, N. Y., are engineers.

Chemistry Building — Fisk University, Nashville, Tenn., awarded contract for the construction of a 2 story, 150 x 180 ft. chemistry building including research laboratories, etc. to Rock City Construction Co., 137 4th Ave. N., Nashville, $160,584. Excavation work under way.

Laboratory—Pittsburgh Hospital, 5911 Center Ave., Pittsburgh, Pa., is receiving bids for the construction of a 5 story, 104 x 135 ft. nurses home, including laboratory, etc. at Frankstown, Washington and Shetland Aves. Estimated cost $300,000. J. F. McWilliams, 6200 Penn Ave., Pittsburgh, is architect.

Laboratory, etc.—Treasury Dept., Office of J. A. Wetmore, Supervising Archt., Washington, D. C., will soon award contract for the construction of a group of buildings including steam laboratory, engineering building, etc. at Coast Guard Academy, New London, Conn.

Laboratory (Chemistry and Physics)—Massachusetts Institute of Technology, K. T. Compton, Pres., Charles River Rd., Cambridge, Mass., awarded contract for the construction of a 5 story, 50 x 300 ft. chemistry and physics laboratory to Stone & Webster Engineering Corp., 49 Federal St., Boston. Estimated cost $800,000.

Laboratory—(Chemistry and Physics)—Radcliffe College, A. L. Comstock, Pres., 10 Garden St., Cambridge, Mass., awarded contract for a chemistry and physics laboratory to Morton C. Tuttle Co., Park Sq. Bldg., Boston. Estimated cost $400,000 to $500,000.

Laboratories—Dept. of Education, Nashville, Tenn., awarded contract for the construction of a science hall including fifteen laboratories, etc. at Murfreesboro to V. L. Nicholson, Nashville. Estimated cost $185,000.

Laboratories — South Carolina Military Academy, Charleston, S. C., awarded contract for the construction of a new college building including laboratories, etc. to Gallivan Construction Co., Greenville. Estimated cost $125,650.

Leather Factory—Korn Leather Co., 10 Walnut St., Peabody, Mass., awarded contract for addition and alterations to factory on Walnut St. to L. Lowe, 6 Tremont Pl., Peabody. Estimated cost $40,000.

Lime Products Plant — California Lime & Products Co., R. L. Hollingsworth, Gen. Mgr., Lincoln, Calif., is having plans prepared for the construction of a 200 ton per day lime plant and 50 ton dry ice plant at Antelope. Estimated cost $500,000. Smith-Emery Co., 651 Howard St., San Francisco, are engineers.

Lime Products Manufacturing Plant—Warner Co., 1616 Walnut St., Philadelphia, Pa., plans the construction of a lime products manufacturing plant and distribution building at Cedar Hollow. $40,000. This is part of proposed $900,000 expansion program.

Plant—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Dec. 26 for a group of buildings including 23 x 41 ft. TNT storage building, 22 x 24 ft. mine filling houses, 21 x 41 ft. crating and painting building, 200 x 201 ft. emply mine storage building, heating and boiler plants, etc. at Naval Ammunition Depot, Hawthorne, Nev. Estimated cost $285,000.

Paint Manufacturing Plant—Corp., c/o H. Holder, 242 Franklin Ave., Brooklyn, N. Y., Archt., will receive bids until Jan. 15 (extended date) for the construction of a paint manufacturing plant.

Paint and Varnish Factory — Sherwin Williams Ltd., 897 Centre St., Montreal, Que., awarded contract for a 61 x 75 ft. addition to paint and varnish factory on St. Charles St., to A. F. Byers & Co. Ltd., 1226 University St. Estimated cost $42,000.

Paper Mill — Champion Coated Paper Co., Hamilton, O., plans the construction of a paper mill near Mobile, Ala. Estimated cost to exceed $1,000,000. Maturity indefinite. Also plans additions to paper mill at Hamilton, O. $150,000. This is part of proposed $1,000,000 expansion program.

Paper Mill — Champion Fibre Co., Canton, N. C., c/o Champion Coated Paper Co., Hamilton, O., plans the construction of a paper mill at Canton, N. C. Estimated cost $150,000. Maturity in spring.

Paper Plant—Fisher Bros. Paper Co., 118-20 West Columbia St., Fort Wayne, Ind., will receive bids about Dec. 20, for the construction of a 3 story, 30 x 150 ft. paper plant on West Columbia St. Estimated cost $40,000. A. M. Strauss, Fort Wayne, is architect.

Paper Mill — International Paper Co., 220 East 42nd St., New York, N. Y., plans the construction of a pulp and paper mill at Pueblo, Salida or Alamosa, Colo. Estimated cost between $2,500,000 and $5,000,000. Definite location undecided. Maturity after Mar. 1.

Pulp and Paper Plant—G. T. Cameron, c/o San Francisco Chronicle, San Francisco, Calif., has made application for permit to construct a pulp and paper plant and hydro-electric project in vicinity of Juneau at Long, Crater and Dorothy Lakes Alaska. Estimated cost $15,000,000.

Pulp and Paper Mill—H. Chandler, c/o Los Angeles Times, 100 North Broadway, Los Angeles, Calif., had made application to Federal Power Commission for permit to construct a pulp and paper mill and hydro-electric plant in vicinity of Juneau, Alaska. Estimated cost approximately $15,000,000. Maturity indefinite.

Pulp and Paper Mill—I. and J. D. Zellerbach, c/o Zellerbach Paper Co., 534 Battery St., San Francisco, Calif., has made application to Federal Power Commission for permit to construct a pulp and paper mill and hydro-electric plant in vicinity of Kelchikan Alaska. Estimated cost $15,000,000.

Pulp Mill—Weyerhauser Timber Co., Longview, Wash., awarded contract for the construction of a 150 ton bleached sulphite pulp mill to Chris Kuppler Sons Co., Port Angeles.

Pottery Plant—Trenton Potteries Co., North Clinton Ave., Trenton, N. J., awarded contract for the construction of a 40 x 200 ft. addition to pottery plant on North Clinton Ave., to S. W. Mather & Son, 300 Maple Ave., Trenton. Estimated cost $50,000.

Powder Magazine Buildings — Quartermaster Corps., War Dept., Washington, D. C., will receive bids until Jan. 5 for one black powder magazine and one combined timer and fuse magazine at Randolph Field, (14 mi. north of San Antonio) Tex. Estimated cost $15,000.

Oil Products Plant—Merific Products Co., Granite City, Ill., plans the construction of a 1 story factory for the manufacture of rolling mill grease, cup grease and other lubricants and heavy oil products on Second St. N. E. Estimated cost $40,000. Private plans.

Refinery (Oil)—Aguila Oil Co., Mexico City, Mexico, (Mexican Eagle Oil Co.) plans the construction of an oil refinery at Atzacapotzalco. Estimated cost to exceed $500,000.

Refinery (Oil) — Chickasha Cotton Oil Co. Chickasha, Okla., plans the construction of a 3 story, 77 x 142 ft. oil refinery. Estimated cost $50,000. E. H. Eods & Co., Hall-Bricoe Bldg., Chickasha, are architects.

Refinery (Oil)—McKean County Refining Co., W. H. Rockman, Farmers Valley, Pa., awarded contract for the construction of a filter house and burner building including filters and conveyors to L. O. Bouquin Co., 11 East First St., Oil City. Estimated cost $45,000.

Refinery (Sugar)—Superior Sugars Ltd., F. J. Potter, 4886 Maplewood Ave., Detroit, Mich., plans to expend $3,000,000 for sugar refinery and equipment including a 250,000 gal. water storage tank, crude oil burners, molasses storage tank and complete equipment for machine and blacksmith shops at Petrolea, Ont.

Refinery (Sugar)—United Fruit Co., Federal St., Boston, Mass., plans the construction of a cane sugar refinery at Kingston, Jamaica, West Indies. Estimated cost $500,000. Maturity indefinite.

Rubber Products Factory—Weldron Roberts Rubber Co., 18 Oliver St., Newark, N. J., postponed construction of 2 story addition to rubber products factory at 361-65 6th Ave., Newark. Estimated cost $40,000. M. N. Shoemaker, 10 Bleecker St., Newark, Archt. Project abandoned.

Silk Mill—Century Ribbon Mills, 80 Madison Ave., New York, N. Y., plans the construction of a 1 story silk mill at Portage, Pa. Architect not selected.

Shell House Magazines—Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for a 1 story, 50 x 110 and 50 x 200 ft. shell house magazines at Naval Ammuniition Depot, Lake Denmark to N. C. Nelson, 855 Broadway, New York, N. Y. Estimated cost $150,000.

Smelter Plant Addition—Niagara Falls Smelting & Refining Co., 2208 Elmwood Ave., Buffalo, N. Y., will soon award contract for the construction of a forge shop. Estimated cost to exceed $40,000.

Smelter Plant—Falconridge Nickel Mines, Ltd., Concourse Bldg., Toronto, Ont., plans addition to converter and smelter plant at Falconridge. Estimated cost $50,000. Private plans.

Tile Factory—Whiteacre-Greer Fireproofing Co., 123 West Madison St., Chicago, Ill., plans the construction of a 2 story tile factory at Waynesburg, O. Estimated cost $40,000. Private plans.

Tile Manufacturing Plant—V. Rivera & Sons, Monterrey, Mexico, plans the construction of a tile manufacturing plant at Brownsville, Tex.

Wood Preserving Plant — Virginia Wood Preserving Corp., Richmond, Va., is having plans prepared for the construction of a wood preserving plant near Richmond. Estimated cost $300,000.

Starch Plant—Piel Bros., 1515 South Dover St., Indianapolis, Ind., awarded contract for the construction of a starch plant to Brown & Mick, 1020 East Michigan St., Indianapolis. Estimated cost $40,000.

Yeast Factory—Anheuser-Busch, Inc., c/o A. A. Busch, Pres., 721 Pestalozzi St., St. Louis, Mo., acquired a site and plans the construction of a 7 or 8 story yeast factory, 100,000 lb. daily capacity including machine shop, garage, power plant, etc. at East Brunswick, N. J. Estimated cost $2,000,000.

INDUSTRIAL NOTES

C. H. WHEELER MFG. COMPANY, Philadelphia, Pa., announces the removal of its New York office to 233 Broadway, where Thos. B. Whitted will be in charge.

SOCONY SPECIALTIES, INC., is the new name of the paint and varnish business of the Standard Oil Company of New York, 26 Broadway.

READING IRON COMPANY announces the election of P. M. Guthrie, Jr., to the presidency of the company, with headquarters in the Baer Building, Reading, Pa.

UNIVERSAL GEAR CORPORATION, 327 So. La Salle Street, Chicago, Ill., has announced the appointment of John C. Phelps as sales manager. Fred M. Potgieter continues in charge as vice-president and general manager.

DETROIT GRAPHITE COMPANY has appointed J. Allan Ritchie Northwest manager of the company with offices in the Lloyd Building, Seattle, Washington.

SHERMAN CORPORATION, BOSTON, MASS., has moved its headquarters to 292 Madison Avenue, New York City. Mr. Austen Bolam, business consultant, is now associated with the firm.

J. BISHOP & COMPANY PLATINUM WORKS, Malvern, Pa., and JOHNSON, MATTHEY & CO., INC., 15 West 47th Street, New York City, have formed a connection whereby the latter house together with its parent company, Johnson, Matthey & Company, Ltd., London, England, acquires an interest in J. Bishop & Co. Platinum Works.

TRUCSON STEEL COMPANY, Youngstown, Ohio, has incorporated the Genfire Steel Company which will function as its dealer and commodity division under the direction of W. B. Turner, formerly manager of the latter company.

GODDARD-JACKSON SALES COMPANY has opened offices at 1331 Santa Fe Avenue, Los Angeles, and will handle the products of the Detroit Oak Belting Company, Pacific Goodrich Company, Mikro Pulverizing Company, United States Electrical Mfg. Company, Lansing Company, National Broach & Machine Co., Power Plant Equipment Company, and Clipper Belt Lacer Company.

CHEMICAL & METALLURGICAL ENGINEERING

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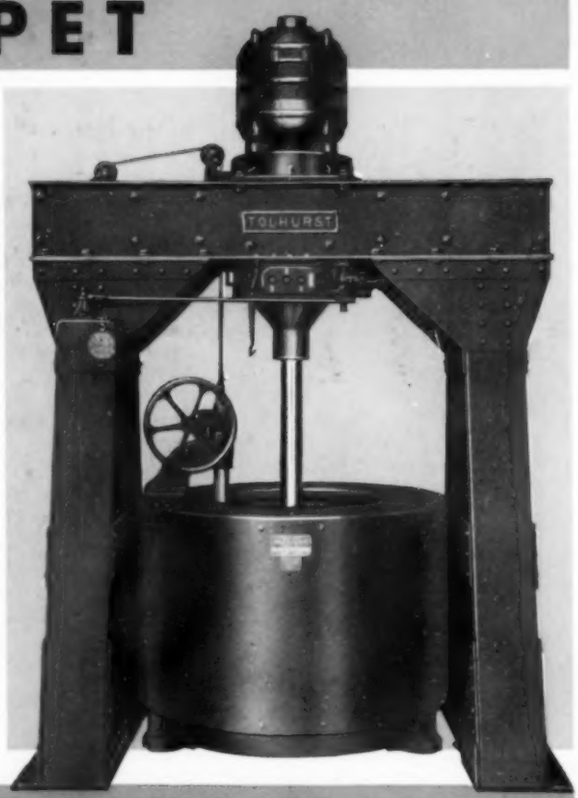
While your good old centrifugals, like faithful employees, have been plugging away, year after year, doing the same old jobs in the same old way with never a complaint, things have been happening in centrifugal design.

Find out if they are doing their jobs the way younger Tolhursts would do them—or if they are using your plant as a quiet Home for the Aged. Are they giving you the Imperforate Basket, the basket that is doing miracles in the separation of unfilterable materials? Are they equipped with the Two-Torque Drive and Mechanical Unloader, devices that have cut whole days out of many processes? Could they be using fume hoods, or automatic timers? Check over your centrifugals, keeping in mind that a good one will last almost forever—will keep on doing its job in the same old way for years and years after improved designs have made it hopelessly obsolete.

May we have an engineer call? Please write.



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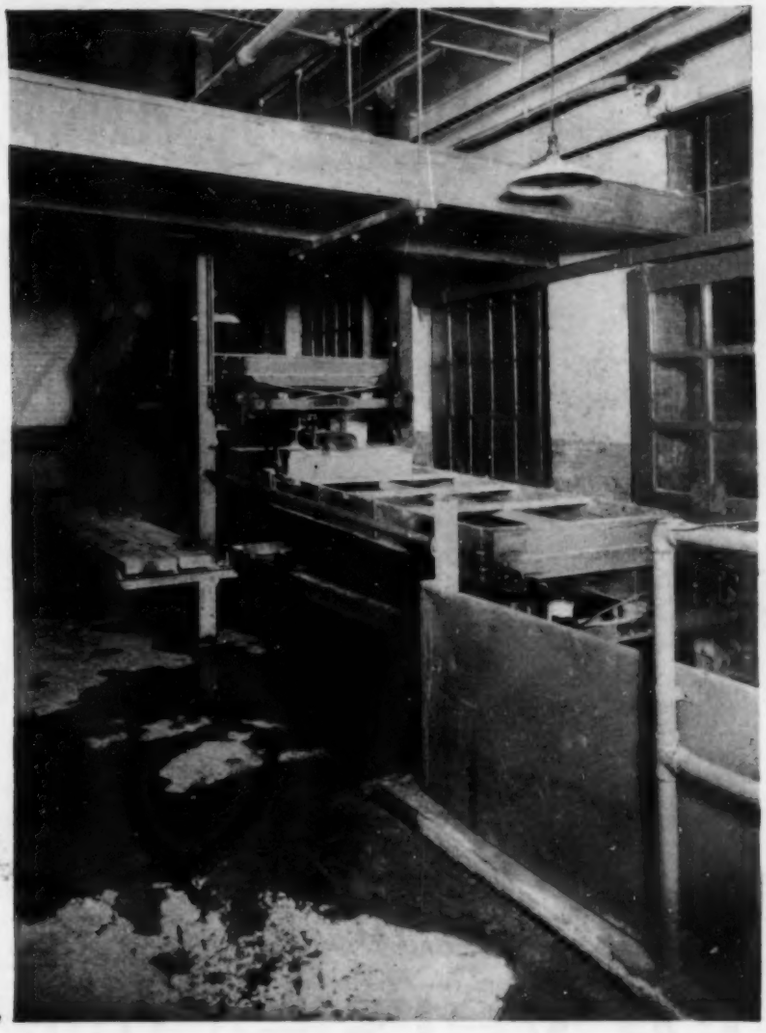
New York Office: 30 Church St.; Chicago Office: 8 So. Dearborn St.; San Francisco Representative: B. M. Pilhashy, Merchants Exchange Bldg., San Francisco, Calif.; Canadian Representative: W. J. Westaway Co., Westaway Bldg., Hamilton, Ont., 455 Craig West, Montreal, P. Q.



Two ROTEX

Screens handling up to three tons an hour of sillimanite porcelain body slip

The ROTEX installation shown above screens the sillimanite porcelain body slip used in making the cores for a nationally known spark plug.

The mixture of the sillimanite and water is about the consistency of a thick cream and is screened through 120 mesh bronze wire screen.

The fact that a maximum capacity of three tons an hour is obtained is a convincing demonstration of the ability of ROTEX to handle large capacities accurately on fine meshes.

Seven years of operation, with these ROTEX still handling their daily output, leaves no question in regard to sturdiness and durability.

There is a ROTEX model that will handle your screening work just as well as these machines are doing this job. Allow our engineers, who specialize on ROTEX, to tell you more about it.

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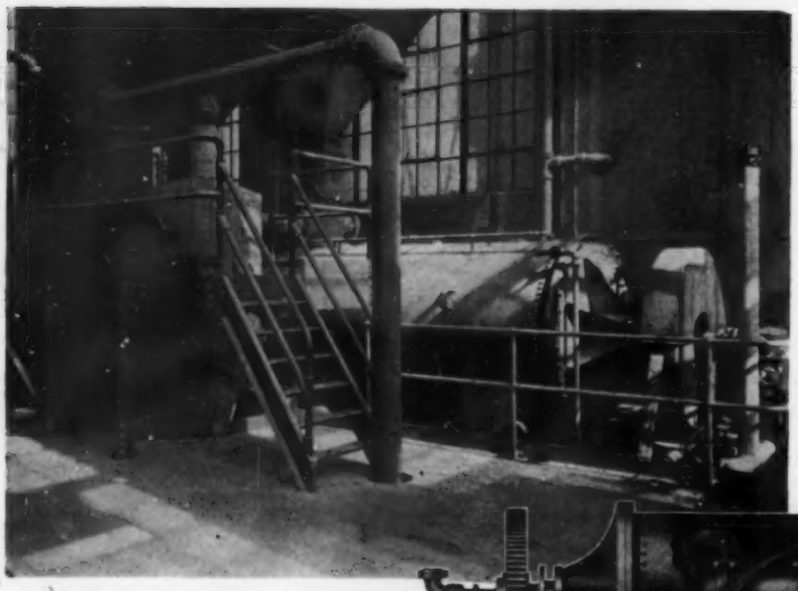
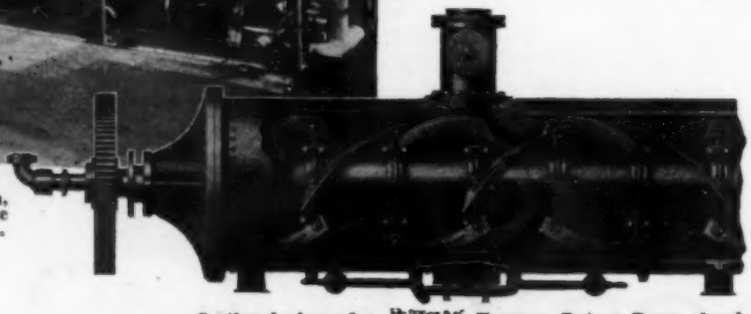


BUFLOVAK Vacuum Rotary Dryer installation, equipped with a direct connected electric drive through a speed reducer . . . . . .

Products that can be dried in BUFLOVAK Vacuum Rotary Dryers:

Balata	Filter Press Cakes
Calcium Hypochlorite	Fish Scrap
Calcium Phosphate	Moulding Powder
Carbon Black	Moulding Starch
Cellulose Acetate	Reclaimed Rubber
Chemicals	Sodium Acetate
Drugs	Sodium Bichromate
Dregs	Sodium Propionate
Dyes	Starch
Filter Clay	Sulphur Black
	Zinc Oxide

Solvent Recovery from Leaching and Extracting Processes.



Sectional view of a BUFLOVAK Vacuum Rotary Dryer showing the patented, helical agitator and discharge door . . . . . .

Successful

Dryers—*a source of profit!*

WHERE drying is a process factor, it frequently may be converted into a profit factor by the correct application of scientifically designed drying equipment. A product better suited to trade demands stimulates sales. That precisely is what BUFLOVAK DRYERS have accomplished in many industries.

Eight standard types of vacuum and atmospheric dryers with many modifications have been designed by BUFLOVAK engineers. The Vacuum Rotary Dryer is a recent, notable example.

For materials which require low temperature treatment and stirring to facilitate drying, this type has already earned some enviable performance records. It is equipped with a patented, helical agitator which lowers power consumption, shortens the drying time, avoids dusting losses and produces a product that is uniformly dry, irrespective of climatic conditions. This type is also successfully used for the recovery of solvents in leaching and extracting processes.

It is completely described in Bulletin 255. A copy will be sent without obligation, upon request.

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DRYERS, 8 types of vacuum and atmospheric equipment for every industrial requirement.

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CHEMICAL PLANT EQUIPMENT.

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COMMERCIAL ACCEPTANCE CO. - - Indianapolis

COMMERCIAL CREDIT COMPANY, Inc., New Orleans
COMMERCIAL CREDIT COMPANY - San Francisco
KEMSLEY, MILLBOURN & CO., Ltd. - New York
CONTINENTAL GUARANTY CORP., Ltd. - Montreal

MIDWEST COMMERCIAL CREDIT COMPANY, Detroit, Des Moines, Milwaukee, Sioux Falls

NATIONAL HEADQUARTERS, Baltimore

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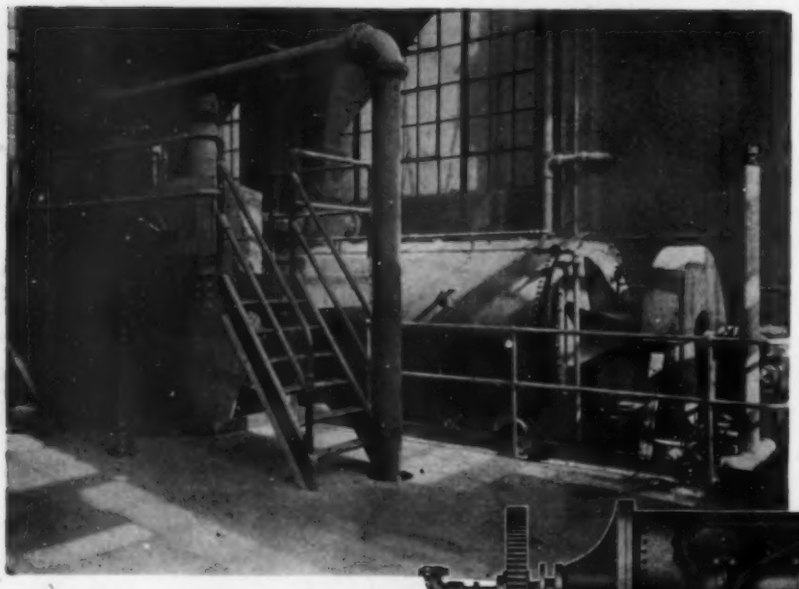

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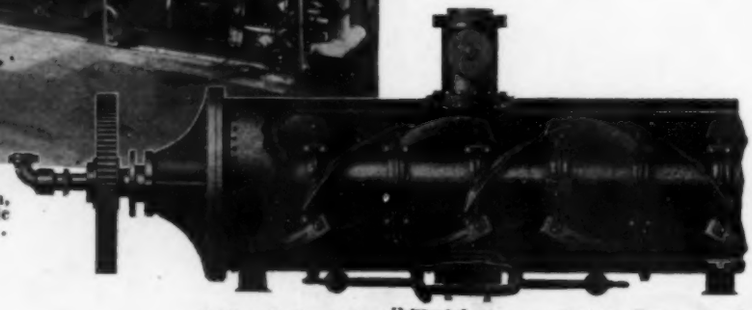
Drugs	Sodium Bichromate
Dregs	Sodium Propionate
Dyes	Starch
Filter Clay	Sulphur Black
	Zinc Oxide

Solvent Recovery from Leaching and Extracting Processes.



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Successful

Dryers—*a source of profit!*

WHERE drying is a process factor, it frequently may be converted into a profit factor by the correct application of scientifically designed drying equipment. A product better suited to trade demands stimulates sales. That precisely is what BUFLOVAK DRYERS have accomplished in many industries.

Eight standard types of vacuum and atmospheric dryers with many modifications have been designed by BUFLOVAK engineers. The Vacuum Rotary Dryer is a recent, notable example.

For materials which require low temperature treatment and stirring to facilitate drying, this type has already earned some enviable performance records. It is equipped with a patented, helical agitator which lowers power consumption, shortens the drying time, avoids dusting losses and produces a product that is uniformly dry, irrespective of climatic conditions. This type is also successfully used for the recovery of solvents in leaching and extracting processes.

It is completely described in Bulletin 255. A copy will be sent without obligation, upon request.

BUFLOVAK PRODUCTS

EVAPORATORS, 11 types, for chemicals, milk, sugar, pharmaceuticals, malt syrup and many food products.

DRYERS, 8 types of vacuum and atmospheric equipment for every industrial requirement.

CHEMICAL CASTINGS.

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Commercial Equipment Corporation, affiliation of Commercial Credit Companies, provides a further financing service to industry. Its method of financing complete installations as a unit, requiring two or more varying types and makes of equipment, has been approved and endorsed by many of the country's leading engineers.

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ANNOUNCING A NEW PROCESS

FOR THE REMOVAL OF HYDROGEN SULPHIDE • H_2S • AND CARBON DIOXIDE • CO_2 • FROM GASEOUS MIXTURES ★

After successful operations in commercial plants, this company announces the Girdler Absorption Process . . . a more *efficient,* more *economical* process for the removal of hydrogen sulphide, carbon dioxide and other acidic gases from refinery, industrial, manufactured and natural gases.

One of the reagents usable in the Girdler Process is Triethanolamine. It possesses a specific absorption capacity of 100 volumes of CO_2 or H_2S per volume of reagent. When diluted 25% with water, it has a capacity of 75 volumes—when diluted 50%, of 50 volumes, etc.

The process is simple *and continuous.* It removes virtually 100% of the H_2S or CO_2 from the gas treated. Its effectiveness and economy increase substantially with (1) the pressure of the gas, and (2) the amount of acid gas to be removed.

THE

The required equipment is *standard,* and is comparatively small and inexpensive.

No undesirable side reactions are caused during absorption—no stable or harmful compounds are formed during reactivation.

The acid gases are removed in concentrated form, which facilitates their disposal or recovery. No odors are imparted by the reagent.

There is no effect on the other normal constituents of the gas under treatment, such as hydro-carbons, carbon monoxide, hydrogen, etc.

Complete reactivation of the reagent is accomplished at low pressures and virtually without loss, simply by heating to approximately the boiling point of water.

The reagent is non-inflammable and non-corrosive to iron and ferrous metals.

Plants are now in operation and being installed. For definite information as to the advantages of the Girdler Process for your particular operations, *write,* giving quantity of gas to be treated, acidic gas content and gas pressure. *Address:* THE GIRDLER CORPORATION, *Incorporated,* Louisville, Kentucky.

★ ***The Girdler Process, covering the use of Triethanolamine and other reagents for the removal of H_2S, CO_2 and other acidic gases from gaseous mixtures, is both broadly and specifically protected by U. S. Letters Patent No. 1,783,901, and other U. S. and foreign letters patent, both allowed and pending, owned solely by the Girdler Corporation.***

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Other Girdler-Operated Companies: THE HELIUM CO., *Incorporated;* TUBE-TURNS, *Incorporated;* VOGT PROCESSES, *Incorporated*

Can *Your* Corrosive Equipment Match *This* Performance

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Read what these manufacturers say about Resisto equipment and the handling of corrosives . . . "five years on dilute sulphuric acid" . . . "six and a half years in a shellac plant" . . . and so on. Not mere opinions, these statements, but actual records of performance sent in by users of Resisto equipment. You can't get stronger proof than such facts! The above are a few of many proofs that *Resisto equipment can lower the cost of handling corrosives.* Write, and a Resisto engineer will gladly call—explain the complete Resisto service—and cooperate with you for lower corrosion loss.

Pipe, Valves, Fittings, Pumps, Tanks, Castings, Special Equipment. Made of Hard Lead, Chrome Alloy, Hard Rubber; or lined with Lead, Tin or Rubber. Contracting Lead Burners.

RESISTO

RESISTO PIPE & VALVE CO.

262 BRIDGE ST., CAMBRIDGE, MASS.

New York Sales Office, 30 Church St.

Large Capacity ~ Little Power Needed ~ Few Wearing Parts

Over 200 Kinds of Material Are

being handled on Jeffrey Troughed Belt Conveyors. For handling your bulk materials they will provide continuous delivery—relatively high speed—large capacity for the size of the conveying unit—and a complete separation of material carried from moving parts.

A controlled steady stream of material can be maintained at a speed that will maintain the desired flow of material through your plant.

In selecting Jeffrey Belt Conveyors users have considered something more than first cost. We believe that you too will be interested in the following features:

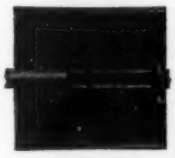
Recessed greased pockets in Jeffrey Pulleys prevent grease buttons from forming in the grease orifice of the hollow shaft, which in ordinary pulleys prevent satisfactory lubrication.

Pulleys are of grey cast iron with a smooth hard surface that resists wear and rust. Only $\frac{5}{16}$-in. clearance between pulleys—belt cannot sag and cut on idlers. Open end pulleys prevent dirt from accumulating on bearings.

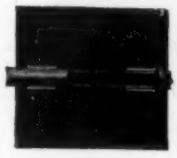
Jeffrey Pulleys are made with three types of bearings: Plain, bronze bushed, and roller and in sizes to meet practically any requirement.

Write now for Catalog No. 409-E.

A Belt Pulley for Every Need



Plain Bearing



Bronze-bushed Bearing

Roller Bearing

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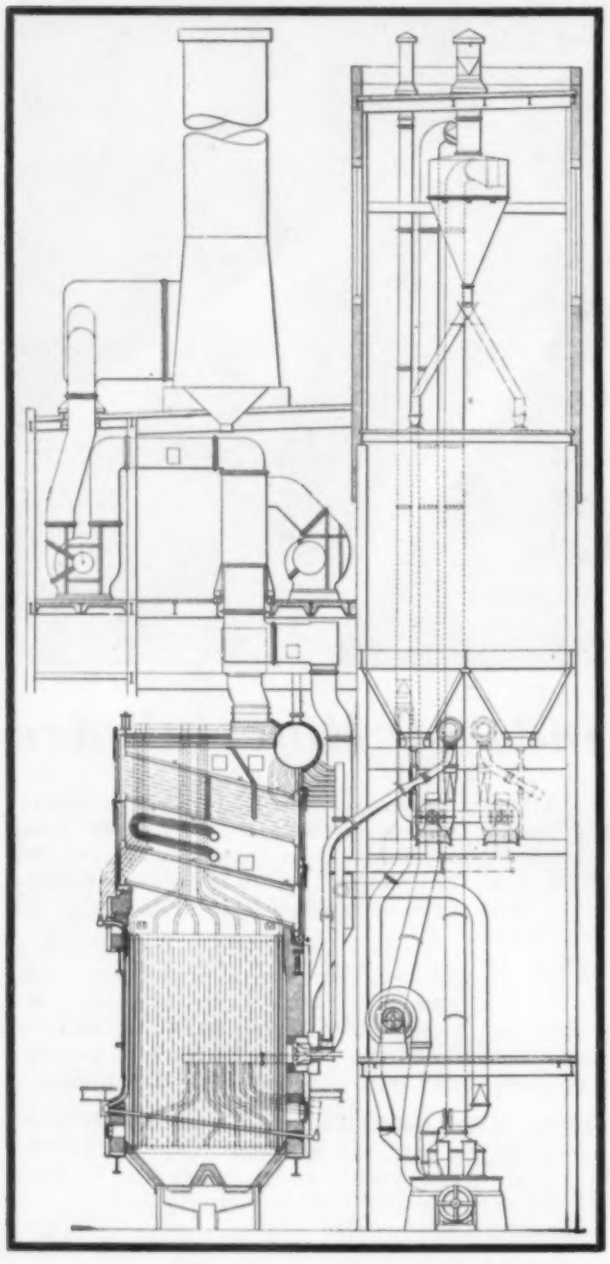
Locomotives

JEFFREY
MATERIAL HANDLING EQUIPMENT

another

C-E Installation *for* Viscose Company



Cross section of new installation for the Parkersburg, West Virginia plant of the Viscose Company.

In 1929 the Viscose Company installed the Lopulco Pulverized Fuel System at their Meadville, Pennsylvania, plant.

Now, in 1930, the Viscose Company has repeated on the Lopulco Pulverized Fuel System for installation at their Parkersburg, West Virginia, plant.

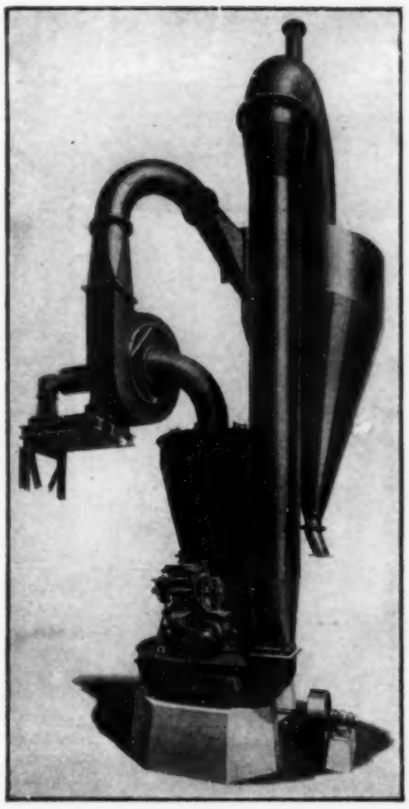
This new installation, designed and manufactured by Combustion Engineering Corporation, will consist of Walsh & Weidner Sectional Header Boiler equipment, Lopulco Pulverized Fuel System (storage type) and all-metal bare tube water walls.

COMBUSTION ENGINEERING CORPORATION

200 Madison Avenue — **New York, N. Y.**

Boilers - Air Preheaters - Stokers - Pulverized Fuel Equipment - Water-Cooled Furnaces

. . . *now available* to Industrial Plants



Typical arrangement of Midget Raymond Roller Mill for grinding a Resin used for molding compounds.

—the advantages of Raymond Roller Mill operation for pulverizing from 500 pounds per hour to 3 tons per hour, depending upon the physical characteristics of the material and the fineness desired.

The Midget Raymond Roller Mill is constructed on the same principle as the larger Raymond Roller Mills and is equipped with all the latest improvements, including enclosed dust-tight gear drive, oil lubricated journals, automatic feed device and pneumatic feed control. Air separation is built integral with the mill—providing for the reduction of materials to extreme fineness and uniformity.

The Midget Raymond Roller Mill may also be operated as a kiln mill—drying and pulverizing in one operation.

A new folder illustrating and describing the Midget Raymond Roller Mill is available. If you desire a copy, write today.

RAYMOND BROS. IMPACT PULVERIZER CO.

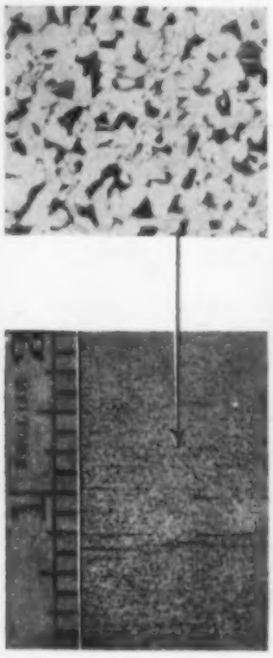
Subsidiary of International Combustion Engineering Corporation

Main Office and Works: 1311 North Branch Street, Chicago, Illinois

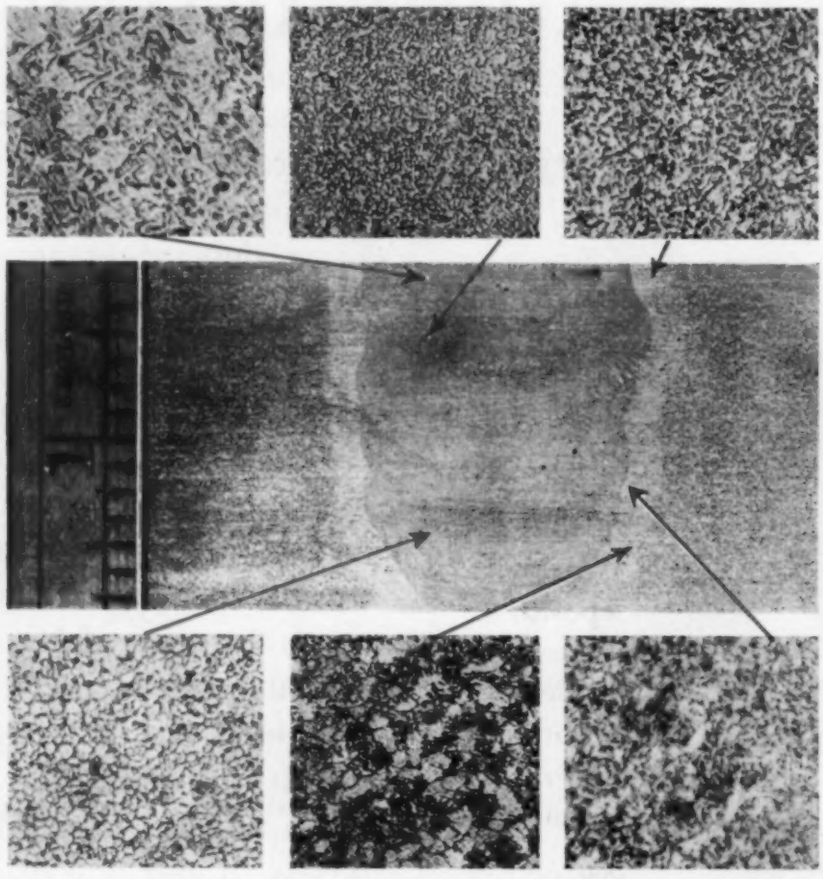
342 Madison Ave., New York

Subway Terminal Bldg., Los Angeles

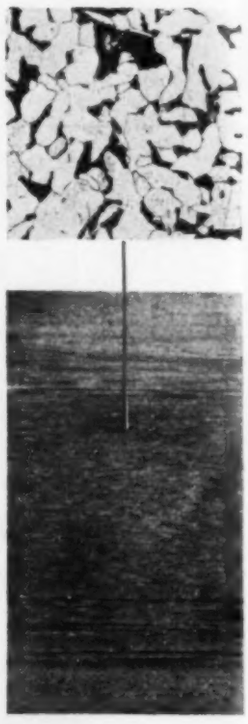
KELLOGG seamless cylinder



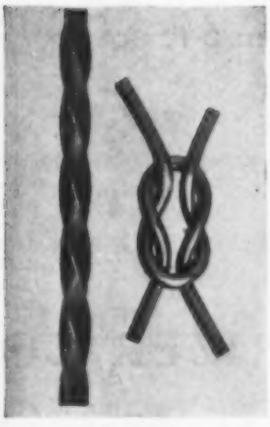
Above: Class A Seamless cylinder material. Minimum tensile strength 60,000 lbs.; yield point 35,000 lbs.; elongation in 2 in. 26%; reduction of area 42%. Specimen etched 40 minutes in hot 1 to 1 hydrochloric acid. Micrograph (top) shows uniformly dense structure. It required 40 minutes of etching to bring out lines in the seamless cylinder material.



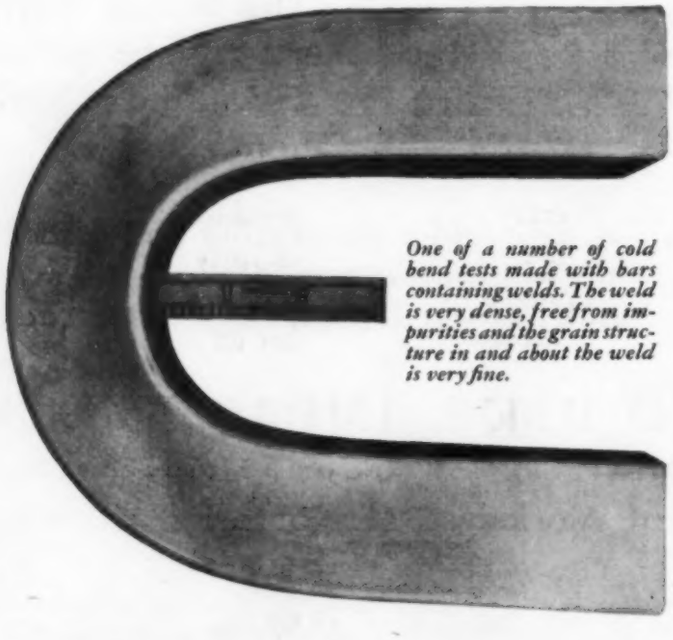
Above: The weld in seamless rolled steel, and six micrographs showing the fine grain structure and unusually clean metal in and about the weld.



Above: Special 50% discard welding quality plate material. Minimum tensile strength 55,000 lbs.; yield point 27,500 lbs.; elongation in 8 in. 25%. Specimen etched 20 minutes in hot 1 to 1 hydrochloric acid. Micrograph (top) shows grain structure. Compare deeper lines with those in rolled steel (extreme left) which was etched 40 minutes.



Above: Ductility tests made with weld metal, a ¾" round specimen tied into a knot cold, and a ⅝" sq. bar that was twisted cold 430 degrees without showing any signs of distress.



One of a number of cold bend tests made with bars containing welds. The weld is very dense, free from impurities and the grain structure in and about the weld is very fine.

Above: Test bar of weld metal, showing remarkable ductility and a perfect fracture. Tensile strength 67,090 lbs.; yield point 58,090 lbs.; elongation in 1.5 inches, 33.3%; reduction of area 63.5%.

fusion welded construction

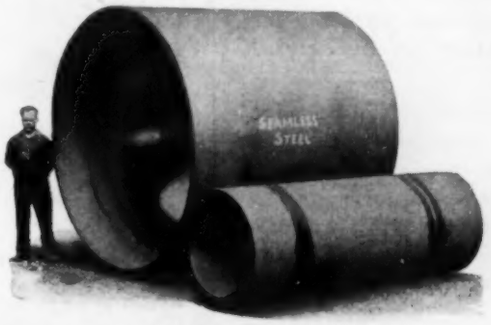
demonstrates . . .

superior tensile strength ductility and density

IN KELLOGG'S electric fusion welding, all variables are automatically controlled. Welds made either in Kellogg seamless cylinders or plate have the full strength of the base metal. A perfect joint is obtained. Both deposited metal and base metal adjacent to the weld have unusual tensile strength, ductility and density. For example, Kellogg all-weld metal is guaranteed to the following minimums:

Tensile strength 60,000 lbs. per sq. inch; yield point 40,000 lbs. per sq. inch; elongation in 2 inches, 20%; reduction of area, 30%.

To the Kellogg fusion welding process, Kellogg rolled seamless cylinders bring a uniformly dense steel that is perfectly adapted. Before being rolled, cropping, piercing and cropping operations remove the highly segregated areas from the ingots. Joined by Kellogg fusion welding, these cylinders form a pressure vessel free from longitudinal seams, with fibres running circumferentially, and having the "skin" of rolled steel that is unusually resistant to corrosion.



Ingot and a finished rolled cylinder. Sizes of pressure vessels fabricated from these cylinders are limited only by transportation facilities.

The complete story of Kellogg seamless cylinder fusion welded pressure vessel construction, with all metallurgical tests illustrated, is contained in a new brochure. Let us send you a copy.

The M. W. KELLOGG COMPANY

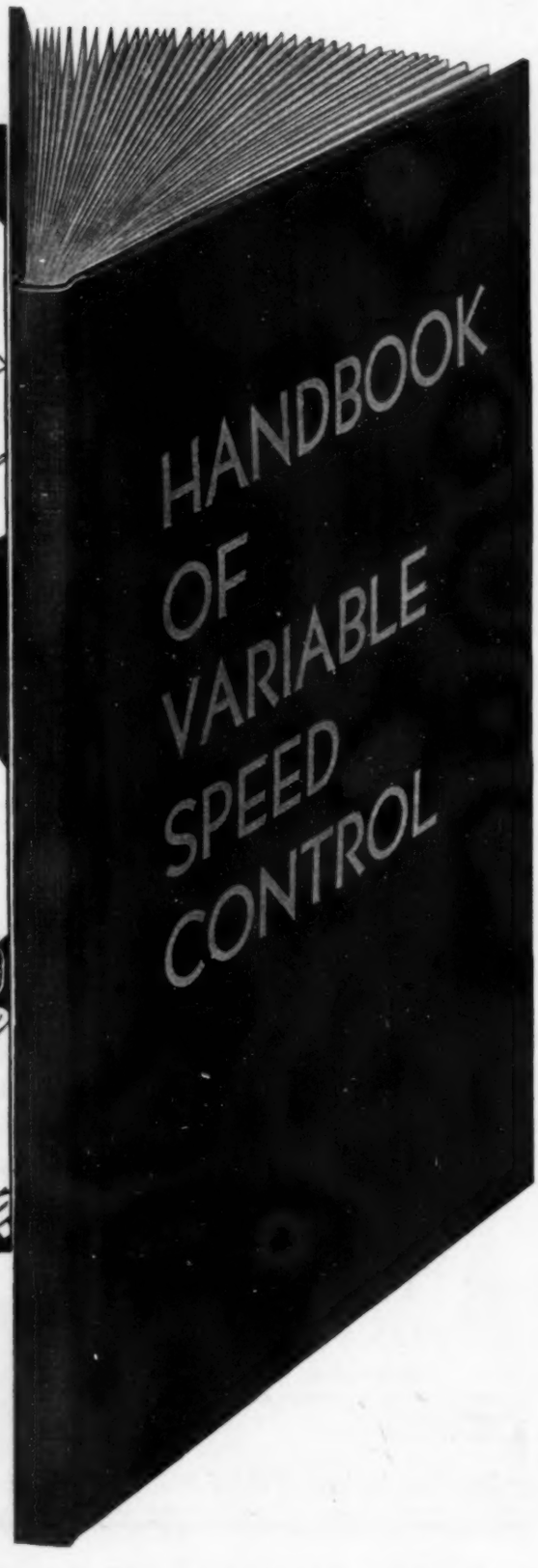
225 BROADWAY NEW YORK, N. Y.

Birmingham, 827 Brown-Marx Building; Boston, 12 Pearl Street; Chicago, 1 La Salle Street; Pittsburgh, Oliver Building; Los Angeles, 742 Western Pacific Building; Tulsa, Philtower Building

Kellogg Products include Welded Boiler Drums, Receivers, Separators, Headers and Complete Power Plant Piping

FREE TO YOU!

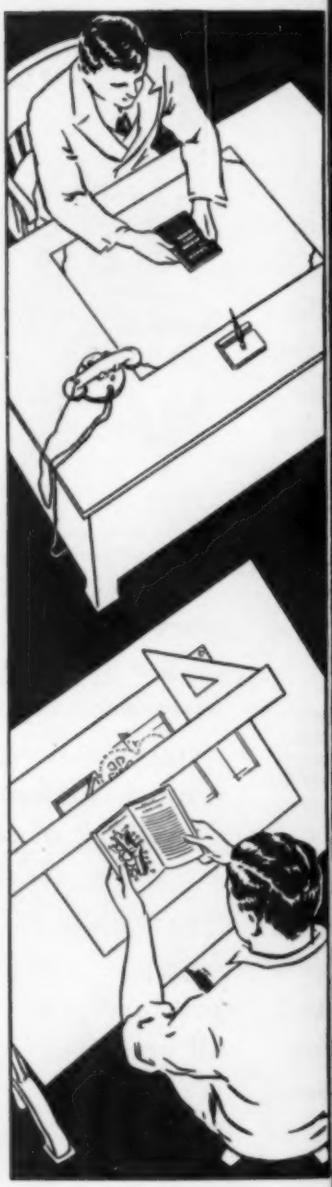
This Valuable Book on the Efficient Speed Control of Production Machinery



Every plant superintendent, every plant owner, every engineer and every machine designer should have a copy of the first edition of this valuable book—a complete and authoritative source of information on the most efficient methods for speed regulation of industrial machinery.

The development of the need for infinite speed regulation . . . the qualifications of speed control equipment . . . the advantages of the REEVES Variable Speed Transmission . . . a list of typical applications in various major industries, naming the machines and plants in which they are in daily use . . . a brief description and illustration of every type of REEVES Transmission . . . convenient charts and tables for the engineer . . . a complete Service Manual covering the installation, operation and maintenance of REEVES Transmissions . . . these and other valuable facts are combined in this convenient, compact, bound book for ready reference.

Regardless of the type of product that you manufacture, this book will be of great interest and value to you. Clip the coupon below and send for your copy today. If you do not use the coupon, be sure to specify Handbook No. C-12.



This book is being distributed only to those who request it

Reeves Pulley Company

Manufacturers of the REEVES *Variable Speed Transmission*

REEVES PULLEY COMPANY, *Columbus, Indiana*

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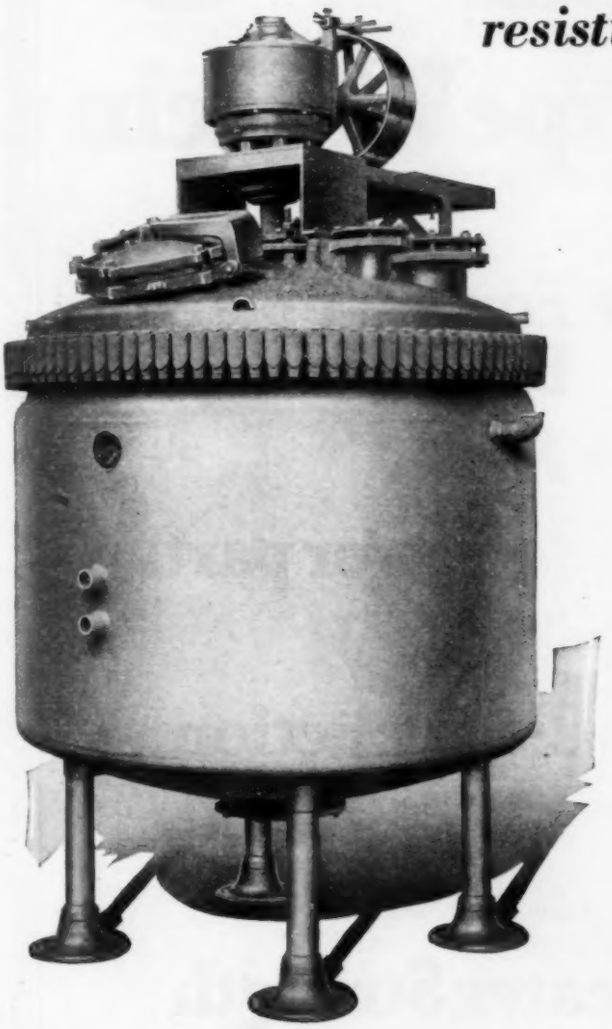
KEEPING DISSOLVED METALS OUT OF PRODUCTS

One of the functions of acid—resisting glass lined equipment



Above: Actual photograph of new standard Pfaudler glass lined reaction kettle or still, 500 gallons capacity . . . one of over 50 standard designs available for all types of chemical service at attractive prices. Send for Catalog 715.

Pfaudler

One of the most important material handling advantages of Pfaudler glass-lined steel equipment is that it remains inert in the presence of acids, mineral and organic.

So if you are handling products containing acids, Pfaudler equipment will eliminate catalytic and other undesirable reactions. When there is no need of subjecting the quality of your product nor the life of your equipment to this action, there is no sense in doing it.

Pfaudler, with 42 years' experience in making high class equipment for over twenty-six industries, is in a unique position to offer you a wide variety of chemical process equipment at interesting prices. Let us submit to you our complete binder of chemical catalogs showing our latest designs. These are available free on request.

THE PFAUDLER CO., *Chemical Division*, 1506 Gas & Electric Bldg., Rochester, N. Y.

NEW YORK	ELYRIA, O.	CHICAGO	SAN FRANCISCO	LOS ANGELES
8 West 40th St.	Pfaudler-Elyria Div.	1422 Conway Bldg.	122 New Montgomery St.	1185 Industrial St.

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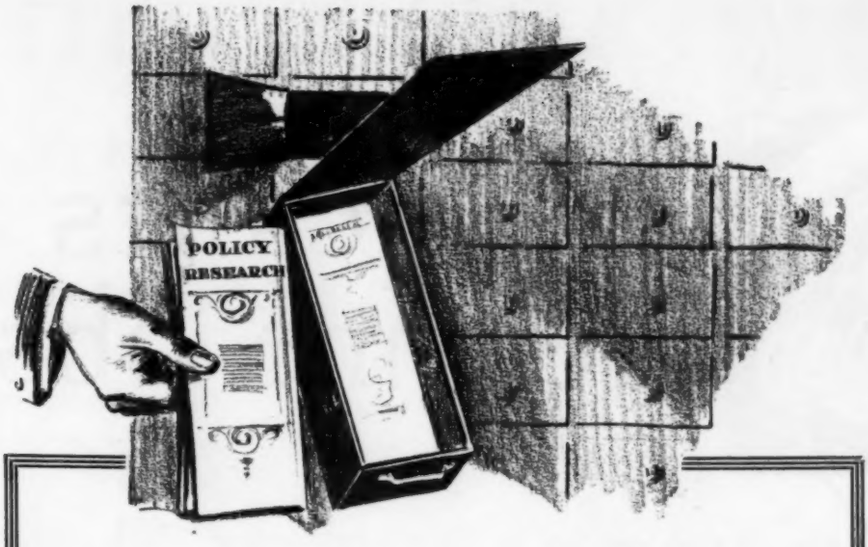

PROTECT Profits Through Research

The outside viewpoint is a valuable means of getting at the inside of a problem.

With industry braking its production to meet the retarded speed of curtailed demand, research is now one of the most important items on your payroll. Keep it there—let it be the endowment policy for the future protection of your business—*and don't let it lapse.*

A great opportunity for research is here now. Whether applied for improving old products, developing new ones, or reducing manufacturing costs, there is a competitive advantage arrived at through research. Many manufacturers realize this. They have found that it doesn't pay to curtail research in times of depression. Those that cut research in 1921 are not doing it now.

The outside viewpoint can shorten the time required to achieve your objectives. It has solved kindred problems for others. It will help you protect the business structure of your entire organization against the keener competition which is already here.

WEISBERG & GREENWALD
ENGINEERS ~ CHEMISTS
71 WEST 45th St. New York

Lubricants also become obsolete.

The oil that you use in the old equipment which you replace probably won't do for the new. Lubricants, like other tools of industry, become obsolete.

Modern methods of intensive production have made necessary considerable changes in the characteristics of lubricants while the importance of lubrication has increased. Constant improvement in equipment has forced many heretofore efficient lubricating oils into obsolescence.

At the same time the problems of getting maximum results from lubrication have multiplied. Today the lubrication of each machine is a distinct problem. The proper lubricant for one unit of equipment may be wholly incorrect for another. Bearings, temperatures, speeds and surface pressures differ widely on different machinery and each of these factors needs careful consideration when selecting lubricants.

Frequently, to obtain correct lubrication, a careful investigation by experts is necessary. Our Lubrication Engineers are prepared to give you such service. Their technical knowledge of lubricants and their broad practical experience enable them to render valuable service to you.

One of these men will be glad to make a survey of your plant and offer recommendations—without charge. Just communicate with our nearest office.

We will gladly send you any information regarding lubrication that you desire. We have many authoritative treatises covering the lubrication of different types of equipment.

One of these bulletins may contain information that will be of great interest to you. Just ask our nearest office for a bulletin giving lubrication data about the particular equipment you are interested in.

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1491

"UNITED" *CHEM-RAYON*

Flanged Acid Valves

"UNITED" hard lead plug and seat or disc type flanged acid valves are lighter, stronger and more acid resistant than the usual valve of this type. The bonnet of the valve is made of steel and brass, completely covered with hard lead with the exception of the handwheel and the bushing support at the extreme top. The stuffing box is much deeper than usually found, permitting more packing to be used which is held in place by a hard lead gland. This reduces leakage to a minimum, thereby eliminating resultant corrosion.

The steel studs used for tightening the stuffing box gland have been placed in the support or tie rod of the specially designed hard lead covered yoke. This positively eliminates the destruction by acid of any of the upper parts of the valve and is an important point. In the ordinary valve the yoke is constantly being replaced.

The valve has been considerably lightened in weight by the use of hard lead fins cast integral with the body. This enables full body strength to be retained and also acts as a reinforcement for the flanges.

"United" Chem-rayon acid valves are made in the "Y" pattern as illustrated or in the usual angle pattern. List of prices on request.

NATIONAL LEAD COMPANY

111 Broadway, New York, N. Y.

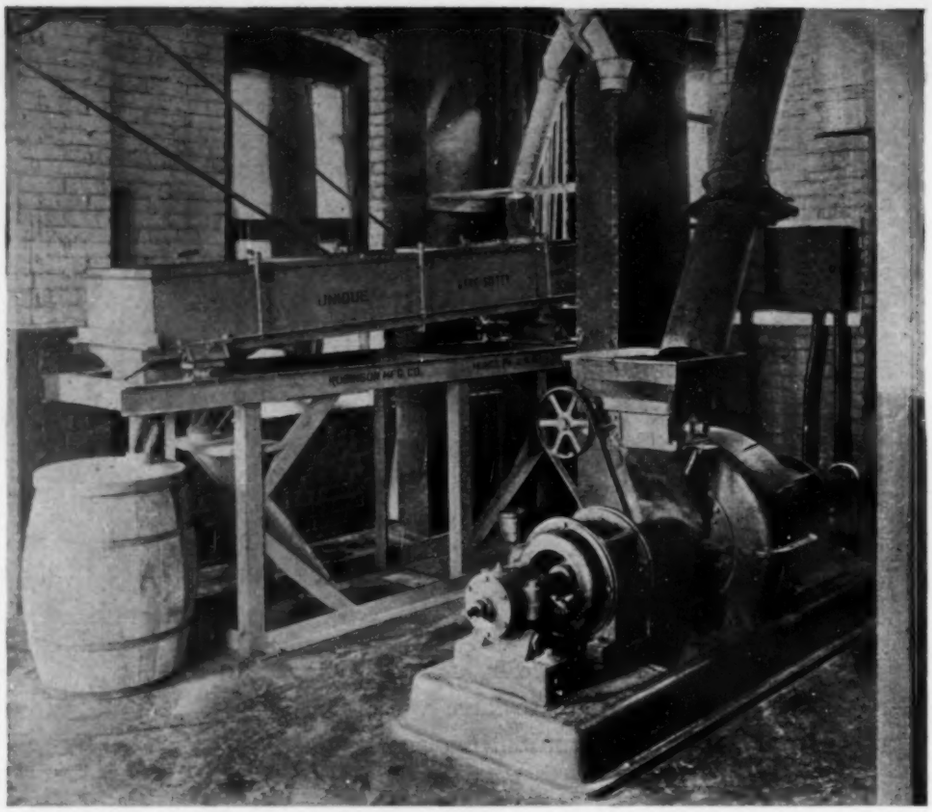
"UNITED"
LINED EQUIPMENT

also includes: "United Tubond" lead-lined and tin-lined pipe; lead-lined and tin-lined fittings; hard lead fittings, cocks and pumps. In addition, National Lead Company are sole selling agents for Homogeneous lead-lined equipment manufactured by the Treadwell Construction Co. of Midland, Pa., such as Homogeneous lead-lined vacuum evaporators, vacuum tanks, steam jacketed kettles, acid eggs, car tanks, digesters, autoclaves and agitators.

BOOST PROSPERITY

BUY NOW

BUT BUY WISELY



Grinding and Sifting Equipment

Here's an efficient combination . . . an Unique Attrition Mill and the Unique Gyro-Sifter . . . used for grinding and sifting various kinds of spices.

The Mill can be set for extremely fine to coarse grinding, while in operation, by a simple turn of a hand wheel. The Gyro-Sifter makes any desired number of separations and maintains close uniformity in all sizes. Good team-work—trouble-free, labor saving, entirely automatic up to the disposition of the finished products.

You may not grind spices; but you should know about

UNIQUE ATTRITION MILLS AND GYRO SIFTERS

if you grind or sift products of any kind. We are prepared to show how Unique equipment can better your product or lower your processing costs—or both. Write us. Put your production problems squarely up to us. We can show you the answer, and prove it.

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Crushers, Grinders, Pulverizers, Sifters, Mixers (Unique and Gardner), Elevators, Conveyors, Sheet Metal Tanks, Bins and Hoppers, Power Connections, Mill Supplies.

ROBINSON SERVICE

We offer you a complete Engineering, Experimental and Advisory Service.

ROBINSON MANUFACTURING CO.

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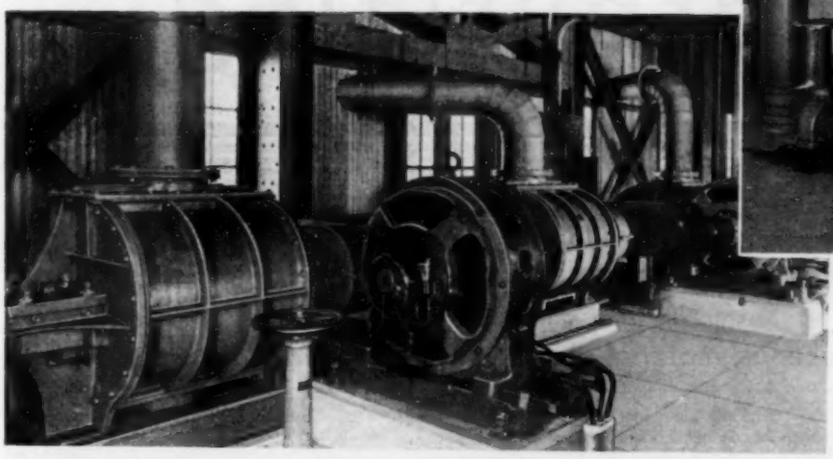
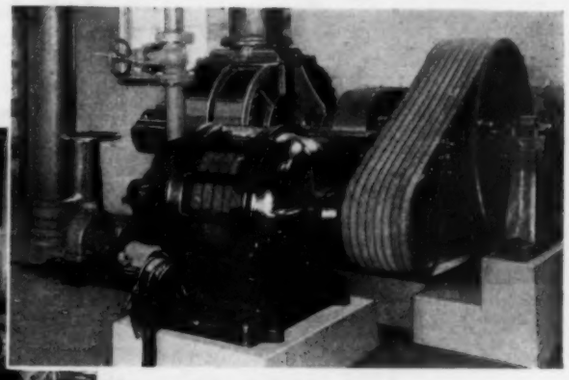
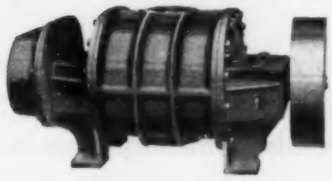
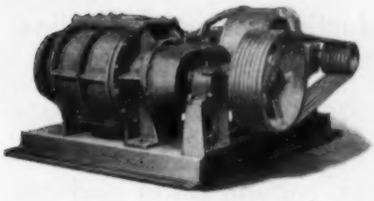
CONVEY PNEUMATICALLY

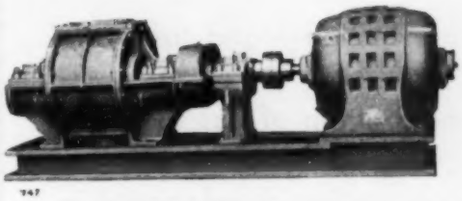
for greater capacities at lower costs











PNEUMATIC conveying has advantages that are unapproachable by other systems from the standpoints of simplicity, adaptability to conditions, little attendance, few repairs and shutdowns. That is why this system is receiving more and more attention from engineers.

In any such system, whether of pressure or of suction type, the blower itself is the heart (or rather, lungs) of the system. Upon the blower hangs the responsibility for the efficiency of the system and not upon a well-arranged piping system alone.

There are definite reasons why Connersville Rotary Positive Blowers, whether for pressure or suction use, are unequalled in this service. Made up primarily of two impellers rotating in a cylindrical casing without internal friction, their positive displacement forces or draws the air through the system at high velocities and in large volumes.

High volumetric efficiency, low costs for power, and sure, positive results are attained with Connersville Blowers. In many installations, they are handling such products as flaxseed, cottonseed, oats, wheat, corn, pulverized coal, lime, sawdust, copra, ashes. Great capacity through longest piping lines is a feature of this equipment.

THE CONNERSVILLE BLOWER COMPANY
Division of The Stacey Engineering Company
Columbia Avenue at 12th Street
CONNERSVILLE, INDIANA

CHICAGO
20 N. Wacker Drive

NEW YORK
420 Lexington Ave.

Blower Division:

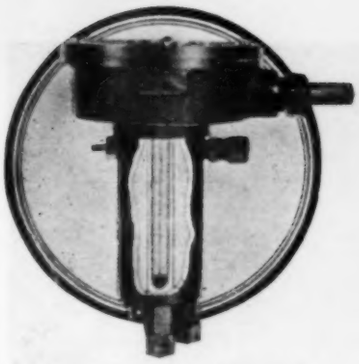
METERS
GAS PUMPS
BLOWERS
"CYCLOIDAL" PUMPS
VACUUM PUMPS
LIQUID PUMPS

Holder Division:

GAS HOLDERS
STACEY "BULLETS"
PURIFIERS
SCRUBBERS
TANKS
PENSTOCKS

CONNERSVILLE

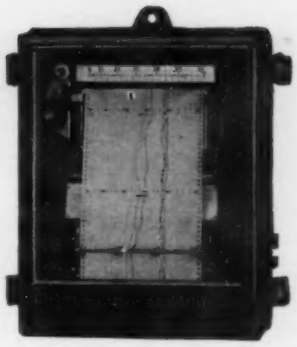
Blowers • Gas Pumps • Meters • Cycloidal Pumps



Thermal Conductivity Cell

No. 1 IN A SERIES OF ADVERTISEMENTS DESCRIBING SPECIFIC APPLICATIONS OF THE ENGELHARD RECORDING GAS ANALYZER

IN MANUFACTURING SYNTHETIC AMMONIA THE ENGELHARD GAS ANALYZER AUTOMATICALLY RECORDS PERCENTAGE OF AMMONIA IN HYDROGEN AND NITROGEN

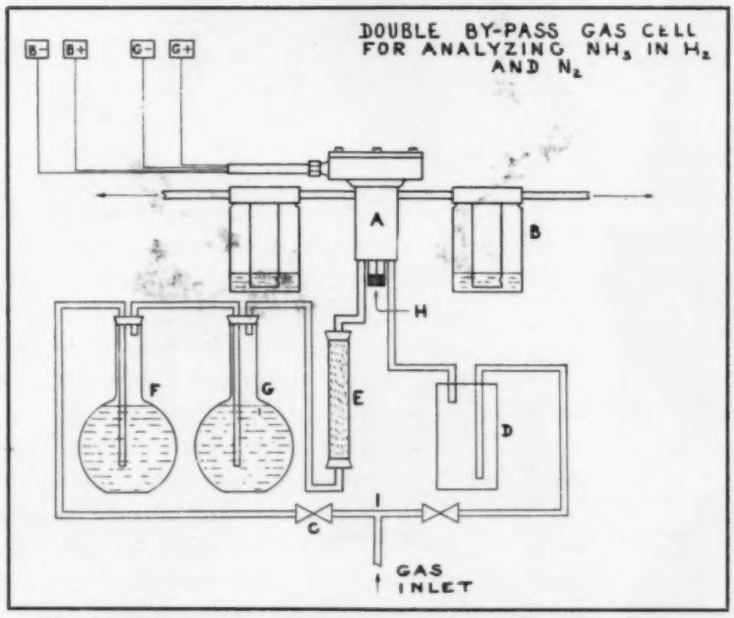


Type S Recorder

IN THE manufacture of synthetic ammonia today, thermal conductivity has been applied for analyzing gases. In this process it is usual to analyze the ratio of hydrogen to nitrogen before the mixture is passed over the catalyst where part of it is converted to ammonia. After conversion the Engelhard Electric Gas Analyzers are applied to analyze the percentage of ammonia in the hydrogen and nitrogen in order to determine and control the efficiency of the converters.

The ammonia oxidation process for the manufacture of nitric acid has also created a new field for gas analyzers. In this process ammonia and air are passed over an active catalyst and oxides of nitrogen are formed. It is essential that a proper ratio of ammonia and air be used as serious losses occur which decrease the overall efficiency of the process if this ratio is not kept fairly constant. Here the Engelhard Recording Electric Analyzer, which is equipped with control contacts for automatically maintaining the proper ratio, proves of great value.

There is a specific Engelhard instrument for each process in manufacturing *synthetic ammonia*—H_2 Analyzer for controlling H_2+N_2 ratios. CO Analyzers to prevent poisoning of catalysts. Inert recorders to detect total inerts in circulating systems. CO_2 recorders for detecting CO_2 in copper snubbers. NH_3 recorders for determining continuous percentage NH_3 in blue gas.



THE ABOVE illustrates an Engelhard thermal conductivity cell for measuring one gas in a mixture of gases. The flasks "f" and "g" may consist of various reagents including conversion furnaces to change the original composition of gas mixture. This is a specific example for the analysis of ammonia in hydrogen and nitrogen regardless of the variation of the various components.

A.....DOUBLE BY-PASS CELL.
The total gas passes through one side of the cell and the total gas (minus the NH_3 which has been scrubbed out) passes through the other side.

B.....GAS FLOW INDICATOR.
Maintain exactly the same same gas flow through both sides of the cell. 160 bubbles of gas through the glycerine per minute.

C.....NEEDLE VALVE.
Regulate the flow of gas by means of these needle valves. (Note—These needle valves must consist of a metal which is not attacked by NH_3.)

D.....LAG COMPENSATING VESSEL.
This gas compensating vessel compensates for gas lag through the scrubbing bottles. In other words the gas divides at point I (see sketch) and both streams should reach cell A at the same time.

F & G...FLASKS.
Both flasks have a capacity of 1000 c.c. Flask F is filled to just below the neck of the flask with 50% H_2O and 50% H_2SO_4. Flask G is filled to the same level with concentrated H_2SO_4. The object of the acid is to absorb the NH_3 as the gas bubbles through.

E.....ASCARITE TUBE.
Consisting of a glass tube 8" long with a 1" inside diameter. This tube is filled with "Ascarite" which neutralizes any acid vapor which may come from the acid scrubbing flasks and therefore prevents this vapor from entering the cell.

H.....ADJUSTING SCREW.
For balancing the cell for zero. (See the operating instructions.)

CHAS. ENGELHARD INC.

233 N.J.R.R. AVE. NEWARK N. J.

Recording and indicating instruments, automatic temperature and gas control, pyrometers, gas analyzers, thermo-couples, thermometers.

STANDARD FOR 30 YEARS

BRANCHES: New York; Boston; Chicago; Pittsburgh; St. Louis; R. E. Chase & Co., Tacoma, Wash.; Jensen Instrument Co., Los Angeles, Cal.; Cleveland Laboratories, Inc., 1988 East 66th St., Cleveland, Ohio. Exclusive Western and Mid-Western Engineer and Service Station.

When You Transfer Laboratory Developments to Production

. . . You can transfer the Equipment, too.

TEST samples from the laboratory need not be so difficult to duplicate in commercial production as they ordinarily are. Eliminate contact with corrosive materials and you remove a considerable source of trouble.

And it can be done. Most PYREX laboratory ware, in which the greater part of laboratory work is done, has grown up to commercial equipment proportions. Take containers for an example—the PYREX flasks and beakers of the laboratory have become carboys, pots, and jars in production equipment. In batch operations especially they provide the highly desirable elimination of contamination from chemical erosion and corrosion. They introduce constant visual control of color and consistency, for PYREX industrial ware is more transparent than the best plate glass.

Physical Characteristics of PYREX Industrial Ware

LINEAR COEFFICIENT OF EXPANSION — .0000032 or less between 19°—350° C.
ELASTICITY COEFFICIENT —6530 kg. per sq. mm.
HARDNESS—Scleroscope, 120.
SPECIFIC GRAVITY—2.25.
SPECIFIC HEAT—0.20.
REFRACTIVE INDEX—1.4754.
DISPERSION—0.00738.
LIGHT TRANSMISSION—Higher than the best plate glass.

Compare the characteristics of PYREX industrial ware with your requirements. Our engineers will gladly suggest means of introducing these characteristics into your equipment, without charge.

▪PYREX▪
INDUSTRIAL WARE
Industrial and Laboratory Division
CORNING GLASS WORKS
CORNING NEW YORK
New York Office, 501 Fifth Avenue

T. M. PYREX Reg. U. S. Pat. Off.

C-8

CHEVRONS *for* SERVICE

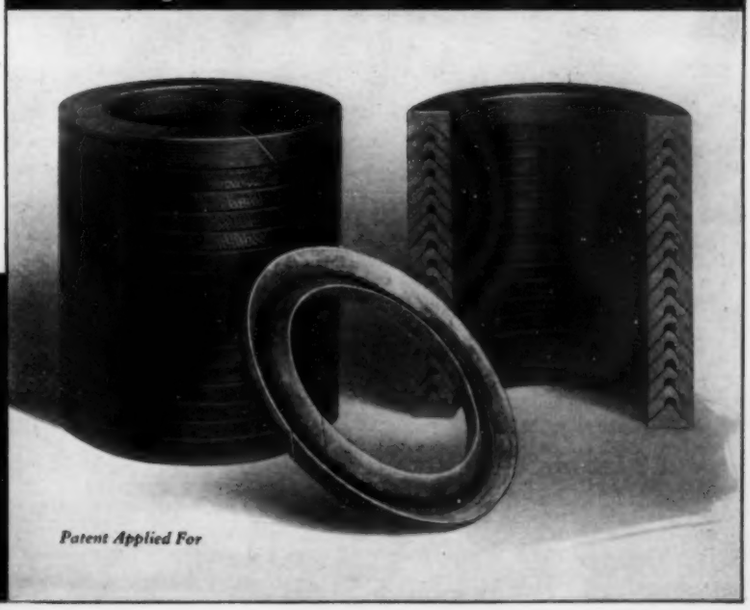
HE'S TOUGH—but he has a tough job. Because he has handled that job well he wears Chevrons—the Army's reward for long and faithful service.

In the industrial field Garlock Chevron Packing handles tough jobs well. It also renders long and faithful service. Like the Sergeant, it has won its Chevrons.

For heavy hydraulic duty we recommend Garlock-430 Chevron Packing. If high temperatures are to be encountered, use Garlock-530 Chevron Packing.

Let the Garlock Service Man tell you the complete story of this new product of the Garlock Factories.

GARLOCK-430 ... *adjusts itself automatically*



Patent Applied For

THE GARLOCK PACKING COMPANY

Palmyra, New York

A World Wide Organization with Sales Offices and Warehouses in all Principal Industrial Centers

REFRACTORY
CEMENTS
to meet every need of HIGH TEMPERATURES OR LOW

THERE is no such thing as a "cure-all" refractory cement. Different conditions call for different types, and in the series of Carborundum-Made Refractory Cements Industry finds just the one to meet specific needs. These cements range from the super-refractory Carbofrax No. 5 for use at temperatures from 2200° to 3300° F. to the Plastic Firefrax No. 1 to be used at temperatures from 40° to 3000° F. ¶And the uses for these cements are decidedly wide and varied—laying up Carbofrax Brick where extremely high temperatures prevail and where ordinary cements would fail—as hot and cold bonding cements—for use in making rammed-up linings and patching, for laying up and repairing fireclay and silica brick work, for laying up insulating brick and a dozen and one other purposes. ¶Each cement in the series is skillfully and scientifically adapted to meet particular conditions. The characteristics of each are well explained in a special pamphlet.

[SAMPLES ON REQUEST]

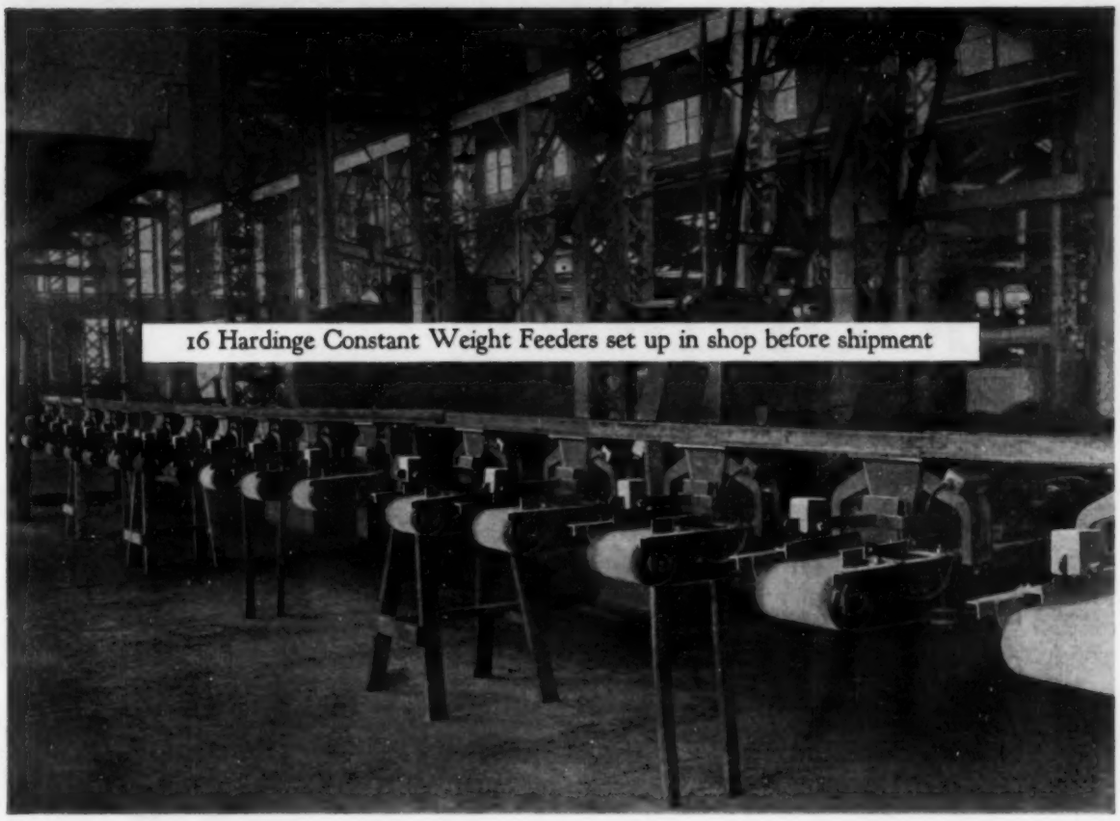
THE CARBORUNDUM COMPANY, PERTH AMBOY, N. J.

REG. U. S. PAT. OFF.

REFRACTORY DIVISION

Christy Firebrick Company, St. Louis, Kansas City, New Orleans, Houston — Pacific Abrasive Supply Co., Los Angeles, San Francisco, Seattle
Harrison & Company, Salt Lake City, Utah — Denver Fireclay Co., El Paso, Texas — Williams and Wilson, Ltd., Montreal-Toronto, Canada

(CARBORUNDUM AND CARBOFRAX ARE REGISTERED TRADE MARKS OF THE CARBORUNDUM COMPANY)



16 Hardinge Constant Weight Feeders set up in shop before shipment

The Simplest of Proportioning Feeders

The Hardinge Constant Weight Feeder controls the feed by weight, thereby eliminating variations due to changes in specific gravity or size of material.

It feeds coarse or fine materials to burners, gasoline filters, mills, dryers, crushers, conveyors, and similar equipment without choking. Two or more of these Feeders, delivering to a common point and controlled simultaneously, will weigh materials at a constant rate, and keep a record of the quantities fed.

Small machines will feed as low as one pound per hour, and the largest machines will feed 1,000 tons per hour.

This Feeder measures by **weight** (not volume)
It records as it operates
It handles coarse or fine materials
It is simple in design and strong in construction
It requires next to no attention from the operator
It is self-contained
It is absolutely accurate
It is very reasonable in price

Write for Bulletin No. 33 on the Hardinge Constant Weight Feeder

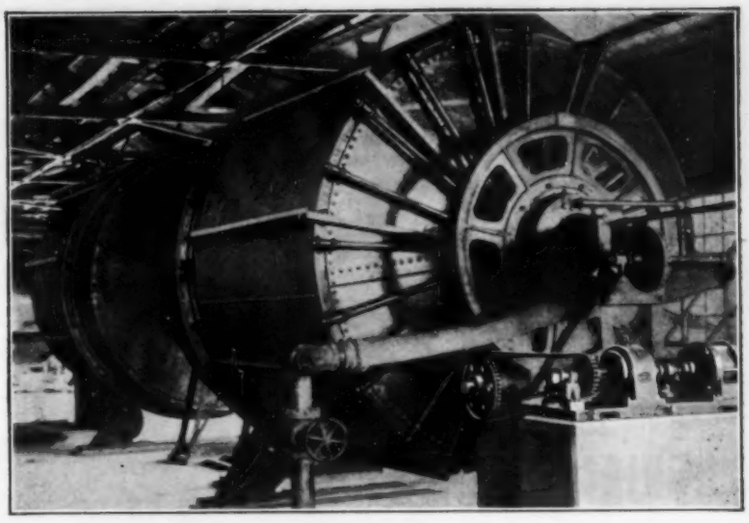
HARDINGE COMPANY
YORK, PENNSYLVANIA
WORKS AND MAIN OFFICE, YORK, PENNA.
BRANCH OFFICES
NEW YORK, N.Y., 122 EAST 42nd STREET
SALT LAKE CITY UTAH, CONTINENTAL BANK BLDG.
CABLE ADDRESS, HARDINGE, NEW YORK

Hardinge

Conical Ball, Pebble and Rod Mills, Ruggles-Coles Dryers, Thickeners, Clarifiers, Sand Filters

For Heavy Duty Drives

—as for instance, this one, handled by a Size 363 Type R-1 Philadelphia Spur Gear Unit driving a 14 ft. Dorrco Rotary Filter—you can rely on any one of the



Spur Gear

Philadelphia

SPEED REDUCING UNITS

(ONE NAME-ALL TYPES)

Here are units that reduce friction to minimum, transmit the maximum amount of power, are impervious to dust, dirt, moisture and fumes, and need no attention except occasional oiling. Roller bearings on high speed shafts, phosphor bronze bushings on low speed shafts.

PHILLIE GEAR

Power Saving Products

GEARS, Spur, Worm, Herringbone, Internal, Bevel, Miter, Intermittent, Spiral, Helical, Continuous Tooth Herringbone Gears, Spiral Bevel Gears, V-Belt Drive Units.

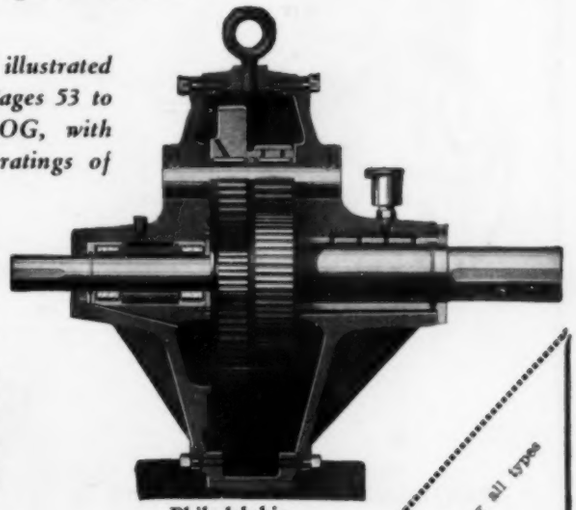
NON-METALLIC PINIONS: Fabroil, Textolite, Rawhide.

Whitney Silent and Roller Chains, Sprockets, Flexible Couplings, Universal Joints, Racks, Ratchets and Pawls, and a complete line of gear driven

SPEED REDUCING UNITS

You will find these Units illustrated and described in detail on Pages 53 to 76 of our NEW CATALOG, with blueprints and horsepower ratings of all types.

Investigate also Philadelphia HERRINGBONE UNITS —ideal for heavy loads at high speeds. Available with Gears of either Continuous Tooth (Sykes type) or Center Groove Type. Remember, Philadelphia makes ALL types of Speed Reducing Units for all forms of drive, all ratios. Send coupon for the Gear Book.



Philadelphia Spur Gear Speed Reducer

Main Office and Plant Erie Ave. and G St. Phila., Pa.

PHILADELPHIA GEAR WORKS

Manufacturers of Industrial Gears and Speed Reducing Units

PHILADELPHIA, PENNA.

Branch Sales and Engineering Offices

New York, 12 E. 41st Street **Pittsburgh, Pa., Farmer's Bank Bldg.**

PHILADELPHIA GEAR WORKS, Erie Ave. and "G" Street, Philadelphia, Pa.
Please send me Catalog 15 illustrating and describing all types of Philadelphia Speed Reducing Units.

Name .....
Company Name .....
Address .....

C&M

A NEW WELDING TECHNIQUE

See other side for details.

THE
BABCOCK & WILCOX
COMPANY

Babcock & Wilcox Welded Boiler Drums For New Scout Cruisers

First approval of Welded Boiler Drums given by Bureau of Engineering, U.S. Navy with order for twenty-four boilers

Fusion Welding is the title of a booklet issued by The Babcock & Wilcox Company describing this new technique. Copies will be furnished upon request.

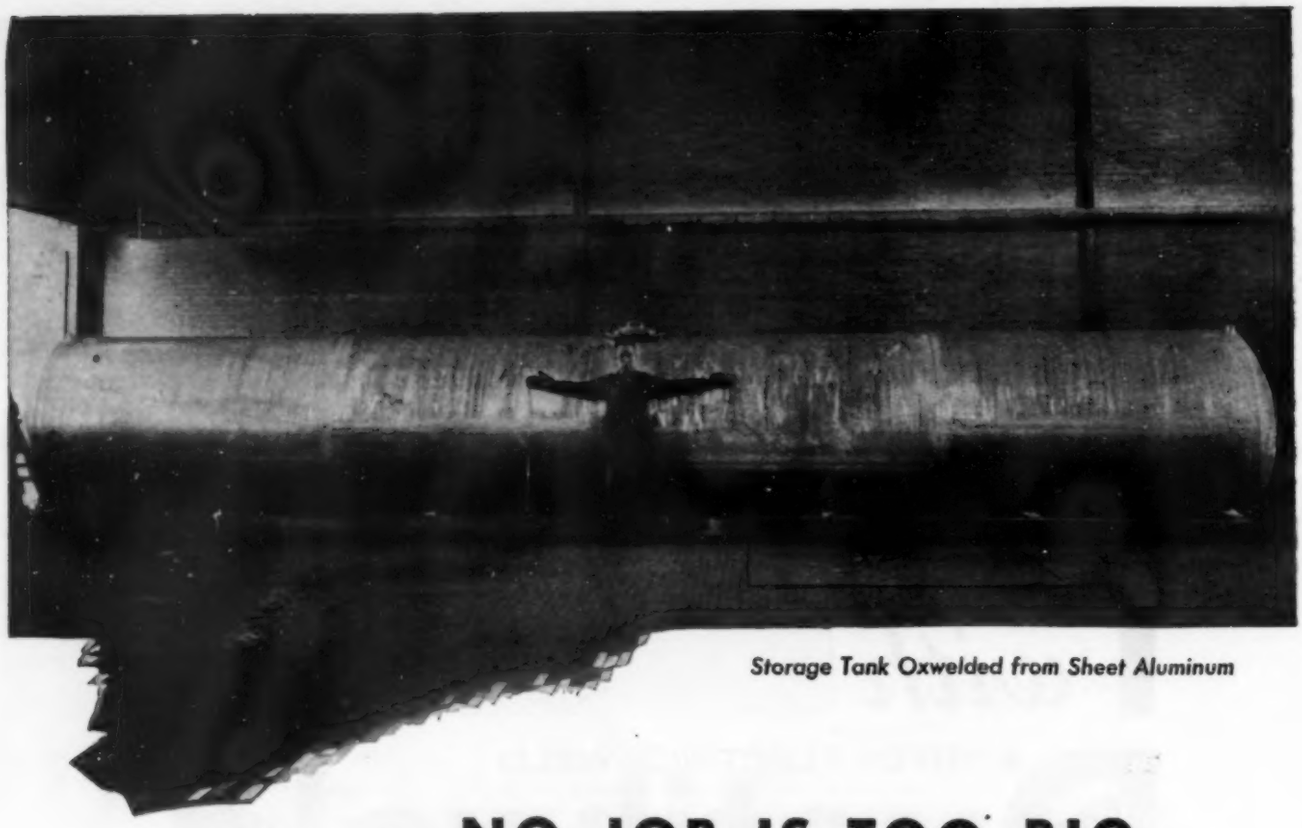
AFTER several years of independent research work, The Babcock & Wilcox Company has developed a new fusion welding technique which consistently produces welds equal to or better than the plate metal in tensile strength, shock resistance, ductility, and ability to withstand repeated stresses.

The nature of this process assures sound welds, but as an additional guaranty the company proves the soundness of welded seams in finished products through the use of X-Ray examinations and other non-destructive tests.

The Bureau of Engineering, United States Navy, has approved the use of this technique in fabricating the drums of twenty-four boilers now being constructed by The Babcox & Wilcox Company for the new scout cruisers, Minneapolis, New Orleans, and Astoria. This is the first time the Bureau has approved fusion welded drums in boiler construction. In fact, it is the first authoritative approval of fusion welded high pressure boiler drums in the United States.

THE
BABCOCK & WILCOX
COMPANY

85 LIBERTY ST. NEW YORK, N. Y.



Storage Tank Oxwelded from Sheet Aluminum

NO JOB IS TOO BIG FOR OXWELDING

Your application of Oxwelding to production need not be deferred because its effective employment in your plant seems difficult or impossible.

The Linde Service and Engineering Organization, qualified by years of experience in adapting this modern metal-working process to the needs of hundreds of highly specialized industries, stands ready to help you apply Oxwelding to your particular production problem.

A wealth of oxwelding information, backed by the resources of one of the country's great commercial research laboratories, is available to you. If your production problem involves welding, investigate these facilities.

THE LINDE AIR PRODUCTS COMPANY, THE PREST-O-LITE COMPANY, INC., OXWELD ACETYLENE COMPANY, UNION CARBIDE SALES COMPANY,

Units of UNION CARBIDE AND CARBON CORPORATION

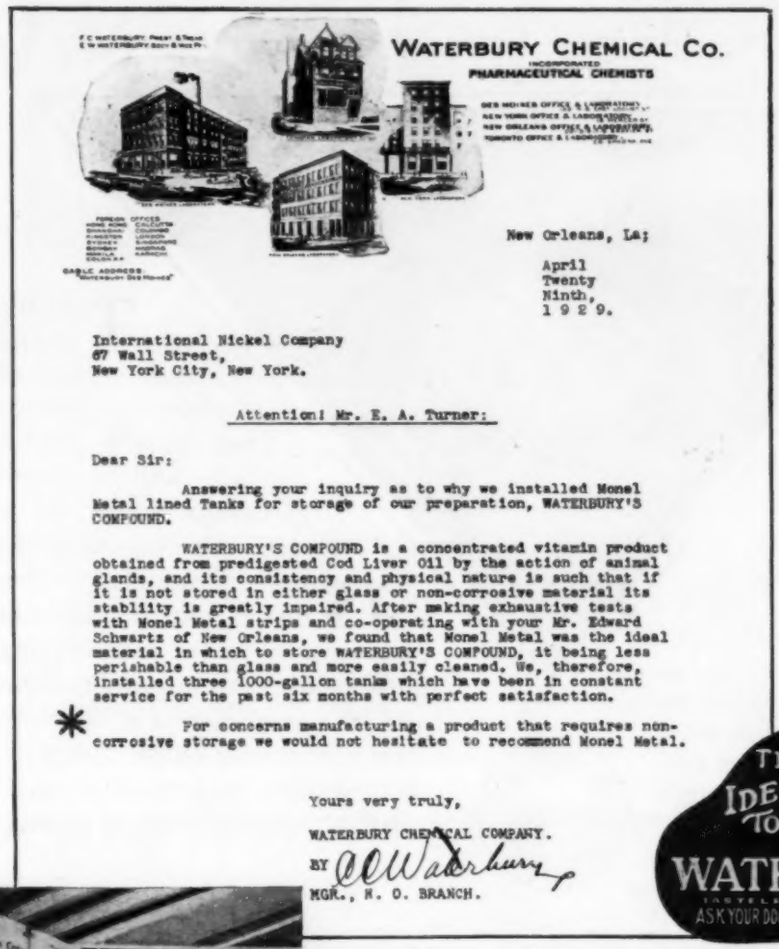
General Offices . . . New York UCC Sales Offices . . . In the Principal Cities

65 Linde plants . . . 48 Prest-O-Lite plants . . . 174 Oxygen Warehouse stocks . . . 156 Acetylene Warehouse stocks

42 Apparatus Warehouse stocks . . . 245 Union Carbide Warehouse stocks

for products requiring

Non-Corrosive Storage*



WATERBURY CHEMICAL CO.
INCORPORATED
PHARMACEUTICAL CHEMISTS

New Orleans, La;

April
Twenty
Ninth,
1929.

International Nickel Company
67 Wall Street,
New York City, New York.

Attention: Mr. E. A. Turner:

Dear Sir:

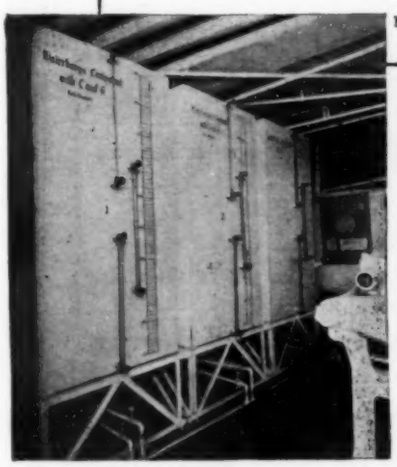
Answering your inquiry as to why we installed Monel Metal lined Tanks for storage of our preparation, WATERBURY'S COMPOUND.

WATERBURY'S COMPOUND is a concentrated vitamin product obtained from predigested Cod Liver Oil by the action of animal glands, and its consistency and physical nature is such that if it is not stored in either glass or non-corrosive material its stability is greatly impaired. After making exhaustive tests with Monel Metal strips and co-operating with your Mr. Edward Schwartz of New Orleans, we found that Monel Metal was the ideal material in which to store WATERBURY'S COMPOUND, it being less perishable than glass and more easily cleaned. We, therefore, installed three 1000-gallon tanks which have been in constant service for the past six months with perfect satisfaction.

* For concerns manufacturing a product that requires non-corrosive storage we would not hesitate to recommend Monel Metal.

Yours very truly,

WATERBURY CHEMICAL COMPANY.
BY C. C. Waterbury
MGR., N. O. BRANCH.



Three 1,000 gallon Monel Metal lined tanks in the New Orleans plant of the Waterbury Chemical Co. Manufactured by J. P. REID, 107 South Robertson Street, New Orleans, La.

TANKS of *Monel Metal*

PHARMACEUTICAL manufacturers are turning to Monel Metal tanks as the solution of their storage problems.

Monel Metal tanks protect the product from contamination. They resist the corrosive attacks of most acids, alkalis and essential oils. They cannot rust and their durability is greater than that of any other available material.

If you have a chemical storage problem, we suggest that you investigate the economy of Monel Metal tanks. Information about Monel Metal in relation to your particular requirements will be gladly sent on request.

Monel Metal is a registered trade mark applied to a technically controlled nickel-copper alloy of high nickel content. Monel Metal is mined, smelted, refined, rolled and marketed solely by International Nickel.

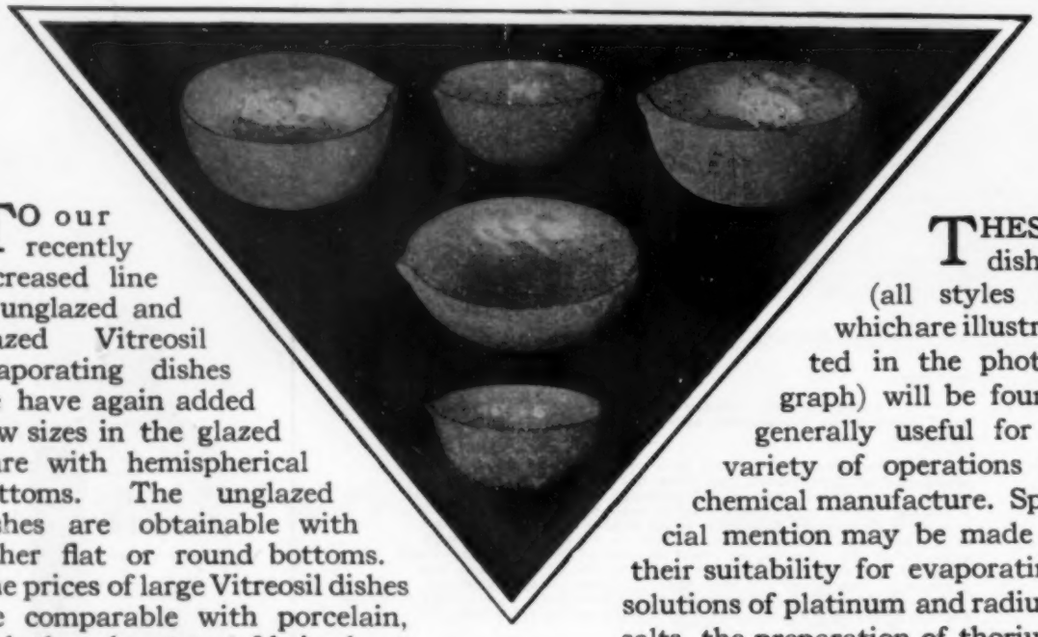
MONEL METAL

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

INCO MONEL METAL

NEW VITREOSIL DISHES

. . . Glazed or Unglazed . . .



TO our recently increased line of unglazed and glazed Vitreosil evaporating dishes we have again added new sizes in the glazed ware with hemispherical bottoms. The unglazed dishes are obtainable with either flat or round bottoms. The prices of large Vitreosil dishes are comparable with porcelain, with the advantage of being least affected by acidic conditions and security against breakage through sudden temperature changes.

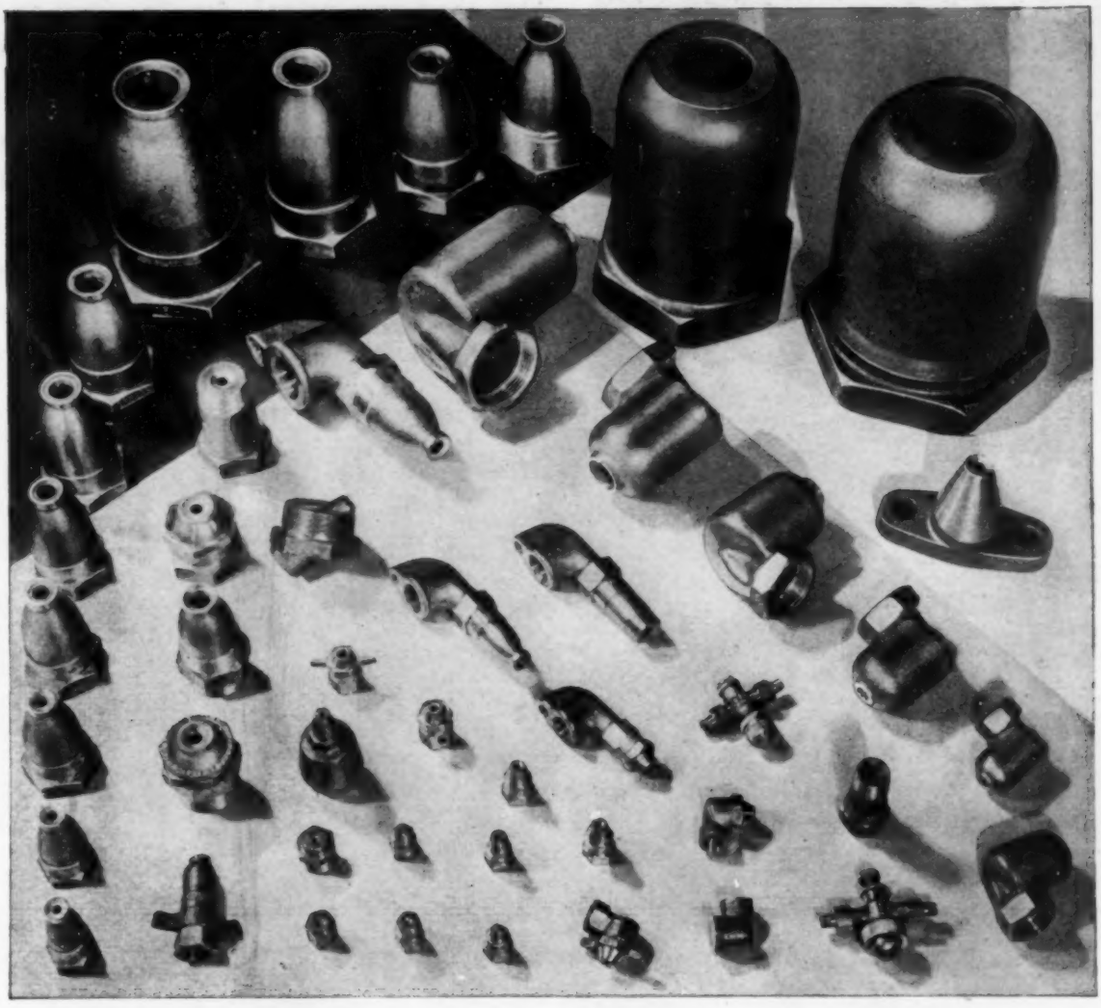
THESE dishes (all styles of which are illustrated in the photograph) will be found generally useful for a variety of operations in chemical manufacture. Special mention may be made of their suitability for evaporating solutions of platinum and radium salts, the preparation of thorium nitrate, mercuric oxide, ammonium tungstate, and tungstic oxide and the resublimation of iodine.

Cat. No. Small Lip*	B.3 *	B.5 *	B.9 *	B.10 *	B.11 *	B.12 *	B.13 *	B.15 *	B.17 *	B.19 *	B.21 *	B.23 *	B.25 *	B.27 *	B.29 Lrg Lip	B.29 *	B.31 *	B.32 Lrg Lip	B.32 *	B.33 *	B.35 Lrg Lip	B.35 *
Approximate Capacity Liters	.045	.080	.100	.200	.400	.500	.600	.700	.800	1.2	1.4	1.8	1.8	2.5	3	4.25	3	10	13.25	15	20.25	22.5
Glazed Round Bottom	$1.50	1.65	2.15	2.50		6.35	8.00	8.35	10.25	10.45	21.25	22.25	25.85	36.75								
Unglazed Round Bottom					$3.85		4.15	4.65	5.00	5.15	5.85	6.65	7.50	8.35	9.40	9.40	11.25	13.25	13.25	13.25	14.25	14.25
Unglazed Flat Bottom											$5.85		7.50		9.40	9.40	11.25			13.25	14.25	14.25

Write for Literature

The THERMAL SYNDICATE *Ltd.*

64 Schenectady Avenue Brooklyn, New York



Spraco Nozzles for process industries

Two-fluid nozzles for intimately mixing two liquids or a liquid and a gas; ramp bottom nozzles for handling (without clogging) liquids containing rubbish or impurities; standard types for every job from powdering milk to spraying asphalt or cake frosting; special types developed to meet specific conditions.

Chemical engineers have found it to their advantage to be familiar with Spraco nozzles. Made in many sizes from brass, bronze, stainless steel, stoneware and special alloys, the line is the most complete one available. Send the coupon below.

SPRACO, INCORPORATED

Formerly Spray Engineering Company

115 CENTRAL STREET, SOMERVILLE, MASS.

Please send Bulletin 463 describing the complete line of Spraco nozzles, including a table of capacities.

Mr. .....

Firm .....

Street .....

City ..... **State** .....

3908

Fit the motor to the job

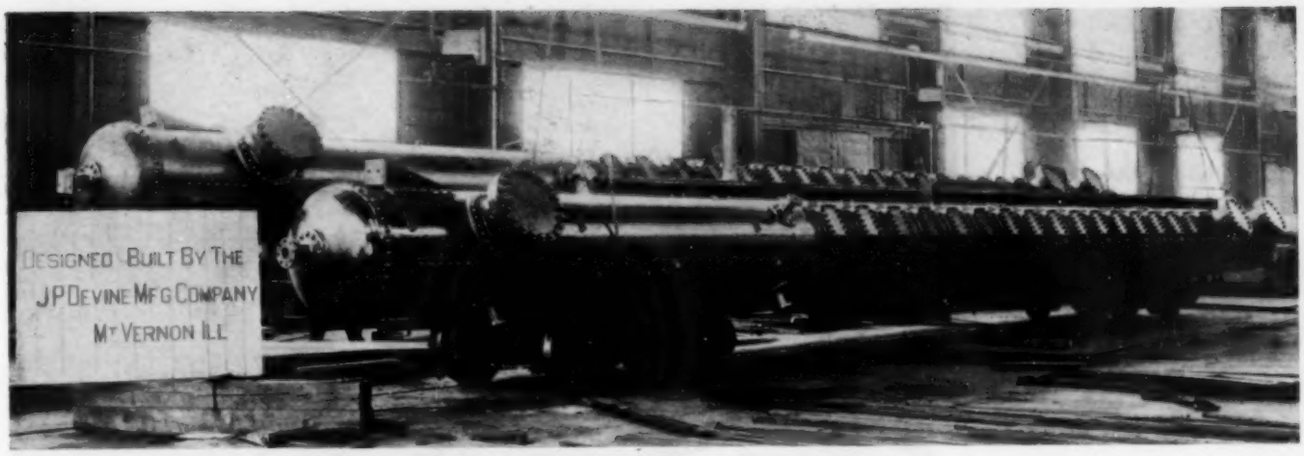
What about your motors? Are they fitted to the jobs to which they are applied? Misapplied motors can frustrate the best management in chemical plants—for it is there that motors are under the severest test. » » » Corrosive dust and fumes, steam and vapor, abrasive dust—inherent in the process industries, are exceptionally severe on motors. » » » The answer to this motor problem is the Wagner air-jacketed motor, completely protected against the destructive elements

which may destroy open type motors in a few weeks. » » » There are many factors involved in the application of motors, factors requiring the consultation of recognized motor specialists. » » » The fact that Wagner manufactures a wide variety of motors (some 25,000 type-hp-rpm combinations) is an assurance to the chemical industries that Wagner sales engineers are qualified to recommend without prejudice the right motor for each job. When motors are under consideration, consult Wagner.

Wagner
Electric Corporation
6400 Plymouth Avenue, Saint Louis, U. S. A.

MOTORS	TRANSFORMERS	FANS
SINGLE-PHASE	DISTRIBUTION	DESK WALL
POLYPHASE	POWER	CEILING
DIRECT CURRENT	INSTRUMENT	VENTILATING

L231-1XD



TWO FRACTIONATING COLUMNS SHIPPED TO A LARGE EASTERN OIL REFINERY » » » » »

These fractionating columns, each 4 feet in diameter by 60 feet long, were built for and are now installed in a well known Eastern oil refinery.

They are typical examples of the modern heavy equipment the J. P. Devine Manufacturing Company is furnishing to many of the foremost process industries. The successful performance of these products reflects the technical knowledge, experience and facilities of the manufacturer.

Purchasers obtain definite advantages and economies from our policy "Petroleum and Chemical Apparatus from Blue Print to Shipment Under One Roof." This centralized responsibility prevents delays and assures scheduled deliveries.

Ideally located and equipped for service to the process industries, the J. P. Devine Manufacturing Company solicits the heaviest of work.

J. P. DEVINE MANUFACTURING COMPANY, INC.

Sales Agents and Fabricators for the Automotive Distillate Corp. of St. Louis

MT. VERNON, ILL.

New York St. Louis Chicago

Another Economical
SPERRY
Filter Press

Hard Rubber
recessed plate type press

SOLID, hard rubber plates have been used on many Sperry Filter Press installations. It affords many practical advantages over other acid-resisting materials.

Exceedingly long life of rubber plates is one advantage over wood. Their flexibility prevents breakage and damage in handling. It affords an extremely tight seal when the press is closed without damaging filter cloths.

In addition to the plates, all head connections are hard rubber as well as hard rubber cocks, fully protecting the material filtered.

Recessed type plates are used in this instance and are arranged for washing.

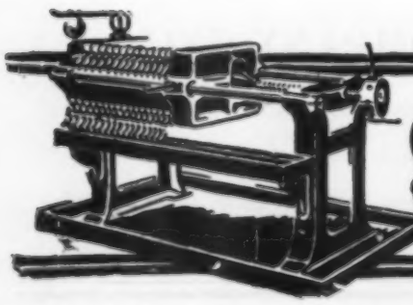
It represents another typical Sperry Press built to suit your particular needs and conditions.

Plate type presses are easily made of acid or alkali resistant materials

D. R. SPERRY & CO., BATAVIA, ILL.

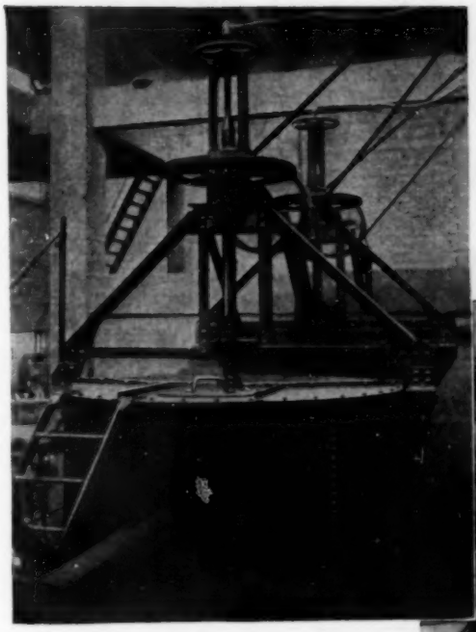
H. E. Jacoby
93 Liberty Street
New York

B. M. Pilhashy
Merchants Exchange Bldg.
San Francisco, Cal.



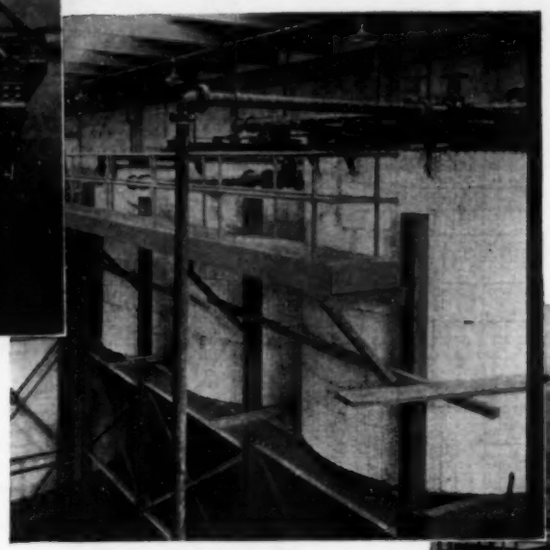
SPERRY FILTER PRESSES

For Every Agitation Need

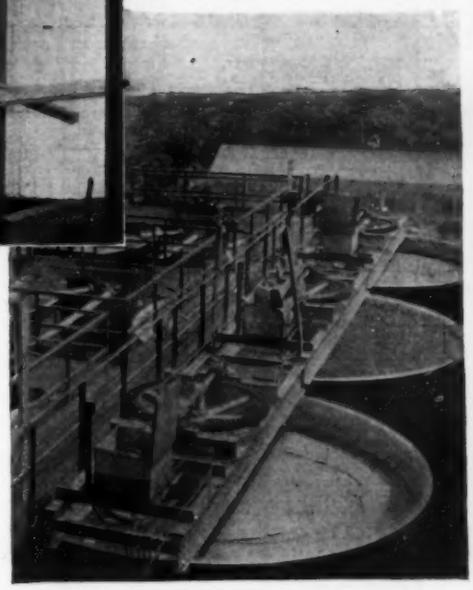


The Dorr Agitator—a combination air-mechanical agitator, for quick and thorough mixing of liquids and solids or of liquids and liquids

PERHAPS you know The Dorr Company chiefly through its thickening, washing, classifying or filtering equipment. Just let us remind you that when you are thinking of agitation or mixing, The Dorr Company can offer you three distinct types of machine, designed to answer most agitation problems.



The Dorr Impeller Agitator—a distinctly different type of agitator, used where the introduction of air is detrimental to the process



The Dorr Slurry Mixer—for heavy duty work or for use in large storage basins

The performance of all three types of Agitator is notable for rapidity of mix, and low power consumption.

Our nearest office will gladly forward bulletins.

The Dorr Agitator,	Bulletin 1081
The Dorr Impeller Agitator,	Bulletin 1271
The Dorr Slurry Mixer,	Bulletin 1181

DORRCO

DENVER, COLO. 1009 17th Street
CHICAGO, ILL. 333 North Michigan Avenue
LOS ANGELES, CAL. 108 West 6th Street
WILKES-BARRE, PA. Miners Bank Building
ATLANTA, GA. 1503 Candler Building
TORONTO, ONT. 330 Bay St.

THE DORR COMPANY

ENGINEERS

247 PARK AVENUE NEW YORK CITY

INVESTIGATION TESTS DESIGN EQUIPMENT

MELBOURNE, AUSTRALIA
Crossle & Duff Pty., Ltd., 360 Collins Street

TOKYO, JAPAN
Andrews & George Co., Inc., Central P. O. Box F-93

LONDON
The Dorr Company, Ltd. Abford House, Wilton Rd., S. W. 1

BERLIN
Dorr Gesellschaft m. b. H. Kielganstr, 1 W. 62

PARIS
Societe Dorr et Cie 26 Rue de la Pepiniere

JOHANNESBURG, S. A.
E. L. Bateman Locarno House

Select the PACKING Best Adapted to the Conditions of Service

The varied conditions under which a packing must work make it necessary that the packing be adapted to such conditions.

No one packing could possibly be expected to meet all conditions.

The A. B. C. *of* Packing		PALMETTO PACKING	CUTNO PACKING	PELRO PACKING	SQUARE PALCO PLAITED PACKING
					
A	Acetone			x	
	Acetic Acid (Glacial & dilute)		x		
	Alum		x		
	Ammonia (Anhydrous & dilute)		x		
	Amyl Acetate (Banana oil)			x	
B	Benzine (Benzol)			x	
	Benzoic Acid	x			
	Borax	x	x		
	Boric Acid	x			
	Bleach Liquor		x		
	Bromine		x		
	Butyl Acetate			x	
C	Calcium Brine				x
	Chlorine		x		
	Citric Acid	x			
	Compressed Air	x			
	Creosote (Coal tar)		x		
E	Ethyl Acetate (Acetic ether)			x	
	Ethyl Alcohol (Grain alcohol) (Concentrated & dilute)		x		
G	Gasoline			x	
H	Hydrochloric Acid (Muriatic)		x		
	Hydrogen Peroxide		x		
K	Kerosene			x	
L	Lactic Acid		x		
	Lime		x		
	Lime Sulphur		x		
M	Methyl Alcohol (Wood alcohol) (Concentrated & dilute)		x		
	Mineral Spirits			x	
N	Naphtha			x	
	Nitric Acid		x		
O	Oleic Acid	x			
	Oxalic Acid	x			
P	Palmitic Acid	x			
	Phosphoric Acid		x		
	Potassium Carbonate (Potash)		x		
	Potassium Cyanide		x		
	Potassium Sulphide		x		
	Potassium Hydroxide (Caustic potash)		x		
S	Sodium Bicarbonate	x			
	Sodium Cyanide		x		
	Sodium Carbonate (Soda ash)		x		
	Sodium Hydroxide (Caustic soda)		x		
	Sodium Bisulphite		x		
	Sodium Silicate (Waterglass)		x		
	Sodium Sulphite	x	x		
	Sodium Sulphide		x		
	Sulphuric (Oil of vitriol)		x		
	Sulphurous		x		
	Salt Cake		x		
	Stearic Acid	x			
	Steam (High pressure, superheat)	x			
T	Tannic Acid	x			
	Tartaric Acid	x			
	Toluene (Toluol)			x	
	Tri-sodium Phosphate		x		
	Turpentine			x	
W	Water (Hot & Cold)				x
X	Xylene (Xylol)			x	

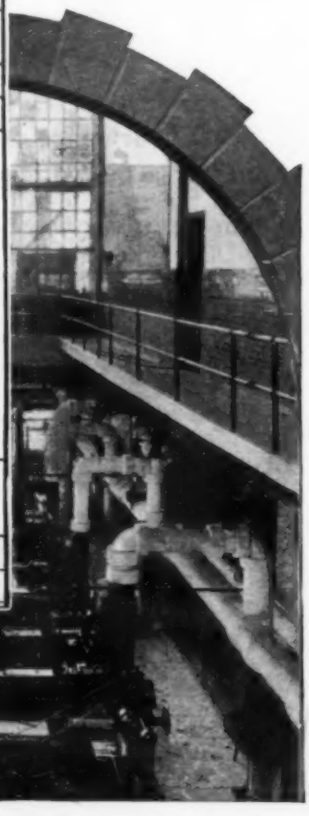
SEND FOR THIS CHART
and
HANG IT UP FOR REFERENCE

COMPRESSED AIR

The high temperature of Compressed Air requires the great heat-resisting quality and perfect lubrication of

"PALMETTO" PACKING

which gives longer and more satisfactory service under compressed air and high-pressure superheated steam than any other packing on the market.



Send for free working sample to test under your own conditions —state full conditions and size packing required for test.

GREENE, TWEED & CO.

Sole Manufacturers

109 Duane St. New York

For Greater Resistance to Acids and Corrosion

SPECIFY

HASTELLOY
TRADE MARK

FOR hydrochloric acid at all temperatures specify Hastelloy "A". This grade also resists sulphuric, acetic, formic and other acids, salt spray and alkalies.

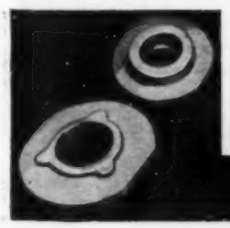
Hastelloy "C" is highly resistant to free chlorine and nitric acid—also hydrochloric, acetic, formic and phosphoric acids and solutions under both oxidizing and reducing conditions.

For resistance to hot or cold sulphuric acid and hydrochloric acid at moderate temperatures specify Hastelloy "D". This grade also shows good resistance to acetic, formic and phosphoric acids.

Hastelloy "A" is supplied in castings, rolled bars or sheets, plates and rolled and cast rounds. Hastelloy "C" and "D" are supplied only in the form of castings.

Write today for additional facts of interest, addressing all communications to the general offices at Kokomo.

HAYNES STELLITE COMPANY

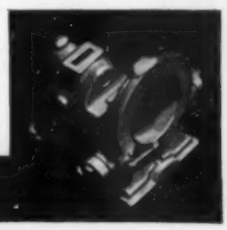


Unit of Union Carbide UCC *and Carbon Corporation*

CHICAGO · DETROIT · LOS ANGELES · SAN FRANCISCO
CLEVELAND · HOUSTON · NEW YORK · TULSA

General Offices and Works — Kokomo, Indiana

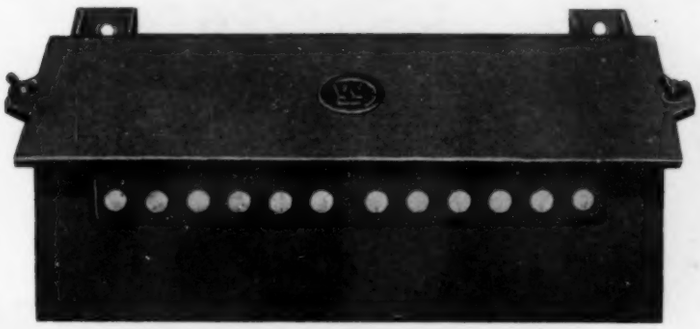
Haynes Stellite Welding Rod is also available from any of the 42 shipping points of the Oxweld Acetylene Company



HAYNES STELLITE · HAYSTELLITE · HASCROME · HASTELLOY

Quality Products, Fair Prices, Dependable Supply, Engineering Service

REDUCE EXPLOSION HAZARDS *with* ACID RESISTING PANELS



Westinghouse 12-circuit Tankless-type Immersed Panel.

ACID VAPORS *can't get in* ARCS *can't get out* . . .

FOR the protection of lighting and power distribution circuits and small motor circuits, Westinghouse has developed an extensive line of oil immersed panelboards which are impervious to the action of corrosive and explosive chemicals.

The panelboards are entirely enclosed either in cast iron housings or in heavy sheet steel tanks with cast iron pot-heads. The housings and tanks are filled with oil. All joints between cover plates, tanks and housings are provided with hemp gaskets. Provisions also are made for making gas-tight conduit connections for incoming and out-going cables.

Therefore, acid vapors cannot reach the panel proper, which is immersed in oil, and the arc formed when a switch opens, cannot come in contact with explosive gases.

Ask our nearest district office for complete information.

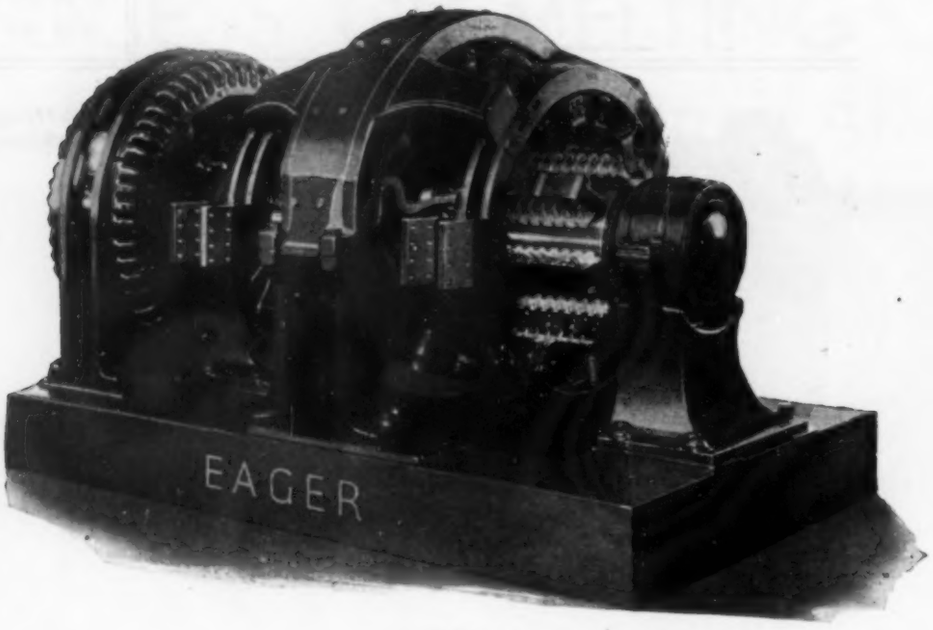
Service, prompt and efficient, by a coast-to-coast chain of well-equipped shops

Westinghouse

T 31612

TUNE IN THE WESTINGHOUSE SALUTE OVER THE N. B. C. NATION-WIDE NETWORK EVERY TUESDAY EVENING.

Safeguards *of* Service



TIMKEN BEARING EQUIPPED

One of the most important requirements in chromium or other plating service is stable terminal voltage. Where motor generators are used to supply power, this requirement means added responsibility for the bearings. Even a slight gap variation, due to bearing wear, will cause unbalanced magnetic strains sufficient to impair the overall efficiency of the set considerably.

The Eager Electric Company, formerly of Watertown, N. Y., now in Cleveland, Ohio, as a division of The Electric Products Company, has settled the question once and for all by equipping its whole line of electrolytic motor generators with Timken Bearings. Thanks to the rigidity with which they hold the shaft to its original setting, the efficiency of the machines and their continuity of service are permanently assured.

Permanently, because they are guarded by the combination that spells unfailing endurance—the Timken combination of Timken tapered construction, Timken positively aligned rolls and Timken-made steel.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN *Tapered Roller* **BEARINGS**

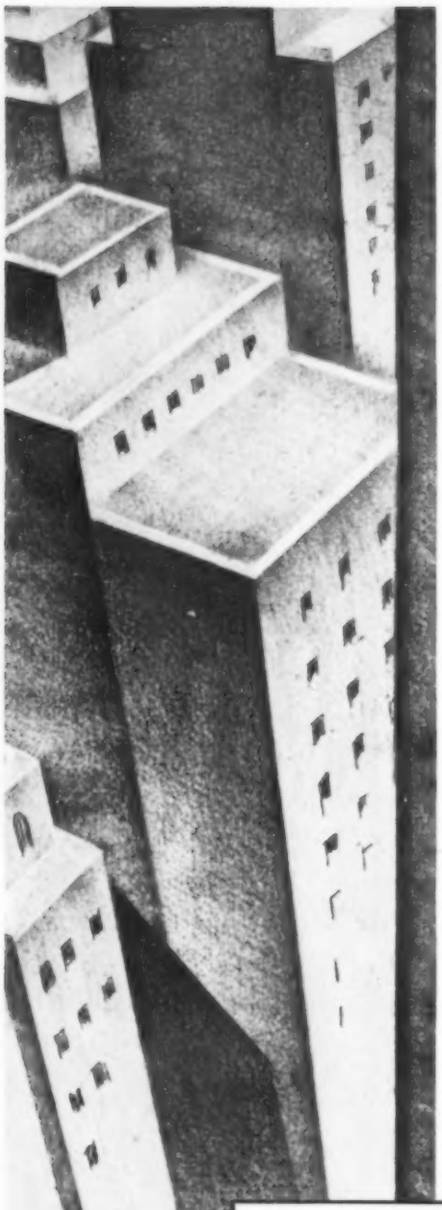
Send for booklet
"Chlorine in its Newest Form."

A
MATHIESON
PRODUCT

Wherever there's a need for STERILIZING—DEODORIZING—DISINFECTING . . . . There's a need for H T H . . . .

Never before has it been possible to utilize so conveniently and safely the widely-known sterilizing, deodorizing and disinfecting properties of chlorine. H T H is a highly concentrated chlorine-carrier. It contains 65% of available chlorine and is a dry, stable, free-flowing powder. It is ideally suited for use in hospitals, industrial plants, water works, food plants—wherever there is a need for a convenient, economical source of chlorine. ¶ For preparing industrial bleaching and sterilizing solutions, antiseptics such as Dakin solution, bleaches, sterilizing agents and disinfectants for household use, ink eradicators . . . . for use in laundries and textile mills as a bleach . . . . in fish packing plants and in ships as a deodorant . . . . in hundreds of diversified uses H T H is meeting a long-standing need. Write for complete information and prices. . . . . .

THE MATHIESON ALKALI WORKS *(Inc.)*, 250 Park Avenue, New York City



A Structure can be no stronger than its FOUNDATIONS

By CARL R. MILLER

No. 6 in a series of advertisements describing the position of The Mathieson Alkali Works in the chemical industry

WHERE plodding oxen once came for a cart of precious salt...today a modern Mathieson plant produces tons of useful chemicals needed for Industry's mills and factories. Near mighty Niagara, unharnessed for ages...today a Mathieson plant extracts power from the falls and elements from air and minerals, transforming them into chemical products that protect the lives of millions...products which cost no more yet serve better.

These modern miracles would have been impossible without strong foundations of Resources, Research and Service...foundations laid in the pioneer days of the chemical industry. That is why Mathieson chemicals represent quality born of seasoned experience...that is also why Mathieson service assures satisfaction to every purchaser.

A list of available literature describing the many uses of Mathieson chemicals will be sent on request.

The MATHIESON ALKALI WORKS (*Inc.*)
250 PARK AVENUE NEW YORK, N. Y.
PHILADELPHIA CHICAGO PROVIDENCE CHARLOTTE CINCINNATI
Works: Niagara Falls, N. Y.—Saltville, Va.
Warehouse Stocks at all Distributing Centers

Soda Ash...Caustic Soda...Bicarbonate of Soda...Liquid Chlorine...HTH (Hypochlorite)...Ammonia, Anhydrous and Aqua...Bleaching Powder...Sulphur Dichloride...PURITE (Fused Soda Ash)

MATHIESON CHEMICALS

MATHIESON CHEMICALS
SERVICE
RESOURCES | RESEARCH
Great Structures Rest on Strong Foundations

The "Big Five" Packers endorse

Dings *High Intensity* **MAGNETIC SEPARATION**

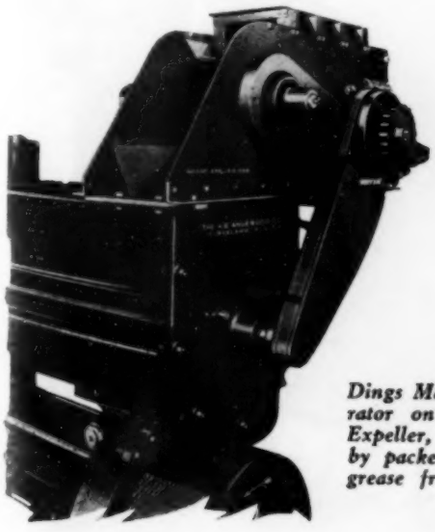
Another industry profiting from protection against iron

LARD, soap, and other packers' by-products is still another industry profiting from the sure protection against iron. Presses that extract grease from inedible parts of cattle break when iron goes through. Dings Magnetic Separators, protecting such equipment, have paid and are paying for themselves over and over again. Hundreds are in service in the plants of the Big Five alone!

Wherever iron can cause defects or impurities in products, wherever materials must be ground, crushed, or pressed, wherever processes produce combustible dusts, Dings pays large returns in cash savings and protection. Check up on the profit possibilities of protection against iron in your own plant.

Boston: 304 Rice Bldg.
Chicago: 273 Seventh Street
New York City: 50 Church Street
San Francisco: 332 S. LaSalle Street

Branch Offices in Other Principal Cities



Dings Magnetic Separator on Anderson Expeller, press used by packers to extract grease from tankage.

Dings Magnetic Separator Co.

666 Smith Street
Milwaukee, Wisconsin
Established in 1899
World's largest manufacturers of magnetic separators

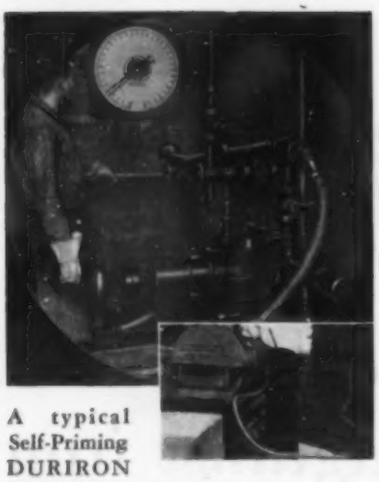
Some of the industries in which 8500 Dings Magnetic Separators are protecting plant and product:

Drugs and Chemicals	Paper
Candy and Sugar	Glass
Cement and Rock	China
Tobacco	Fertilizers
Mining	Packers' Products
Foundry	Grain and Foodstuffs

Tires and Rubber Products

Start 1931 *with*

Let Plant Equipment Be

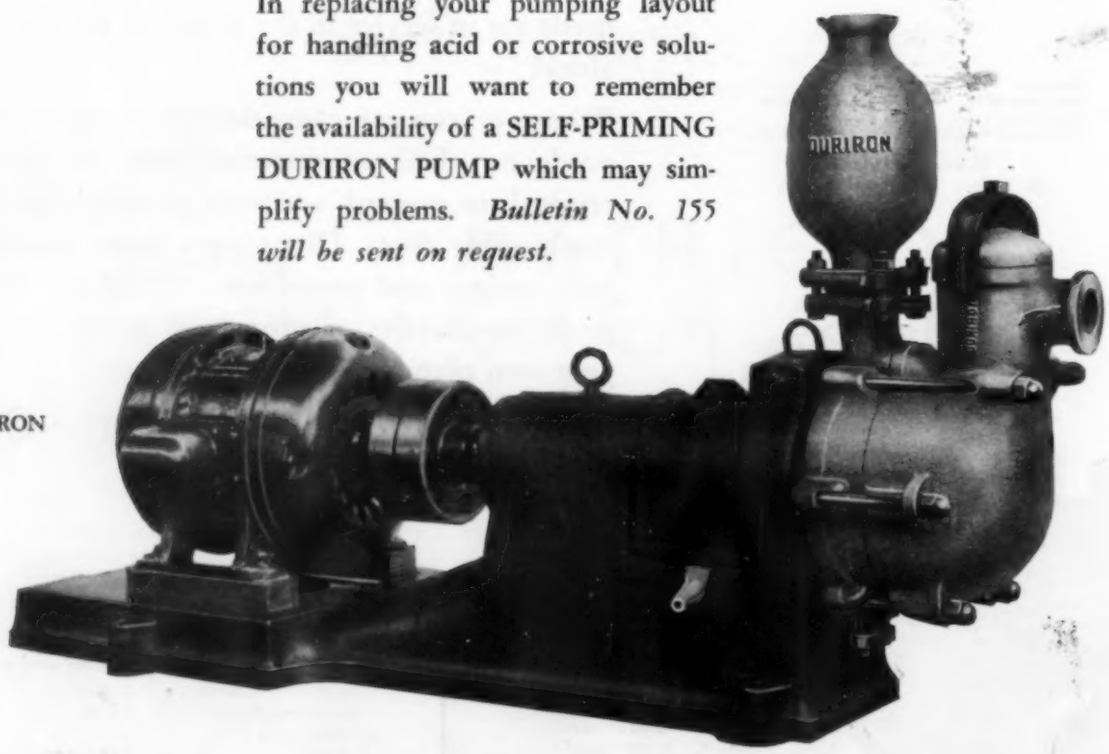


A typical Self-Priming DURIRON Pump installation which is used for tank car unloading and transferring liquids within the plant.

THERE'S no more reason for disassociating first cost and maintenance expense than in putting off the replacement of worn-out plant equipment because you are not running 3 shifts. Let's all turn over a new leaf for 1931.

Let the new equipment be that which will give the most service for the fewest dollars of ultimate total cost. We are willing to buy our equipment on that basis—and we'd like you to look at our product in the same way. DURIRON deserves your preference whenever it can do your work at less cost, over the longest efficient service lifetime.

In replacing your pumping layout for handling acid or corrosive solutions you will want to remember the availability of a SELF-PRIMING DURIRON PUMP which may simplify problems. *Bulletin No. 155 will be sent on request.*



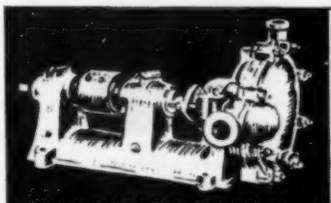
No. 80 DURIRON Self-Priming Centrifugal Pump

Address: THE DURIRON COMPANY, INC., 424 No. Findlay Street, Dayton, Ohio

Sales Engineering Offices in 36 Cities

1931 Policies

Selected for Low Maintenance Cost



DURIRON CENTRIFUGAL PUMPS of small, medium and large capacity

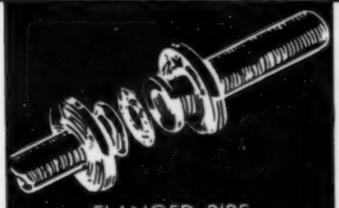
SPECIAL CASTINGS for use under corrosive conditions

ACID-PROOF sinks and plumbing for laboratories

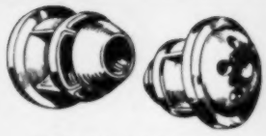
TANK OUTLET and drain fittings for wood, concrete or other tanks

Y-VALVES for 1 to 6 inch pipe lines

KETTLES and Tanks for any corrosive service condition

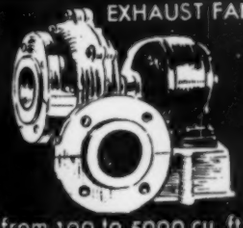


FLANGED PIPE from 1 inch to 8 inch diameter and larger

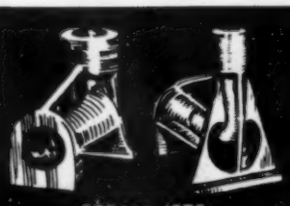


MIXING NOZZLES for intermingling — fluids as in treating at refineries

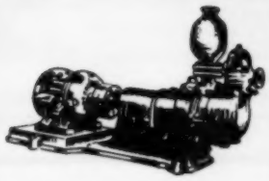
EXHAUST FANS



from 100 to 5000 cu. ft. per min. capacity



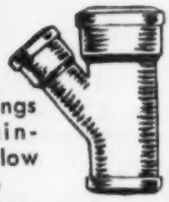
STEAM JETS for heating and circulating corrosive solutions



SELF-PRIMING PUMPS for acid service

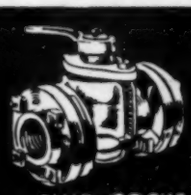
FLOOR DRAINS Sink Outlets and Strainers—Special Tank Fittings

BELL & SPIGOT PIPE and Fittings for drainage and low pressure liquid flow



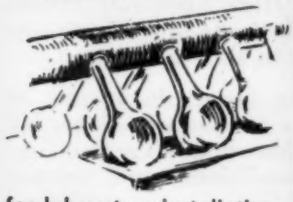
DURIRON CASTINGS

to customers special design



PLUG COCKS including plunger release and Duriron Nordstrom types

DIGESTION EQUIPMENT

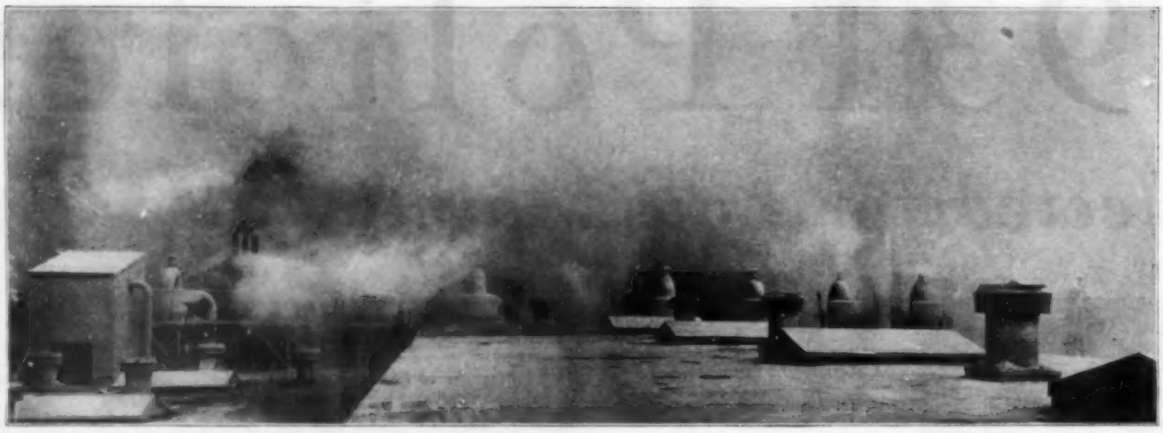


for laboratory installation

JACKETED KETTLES with or without agitators

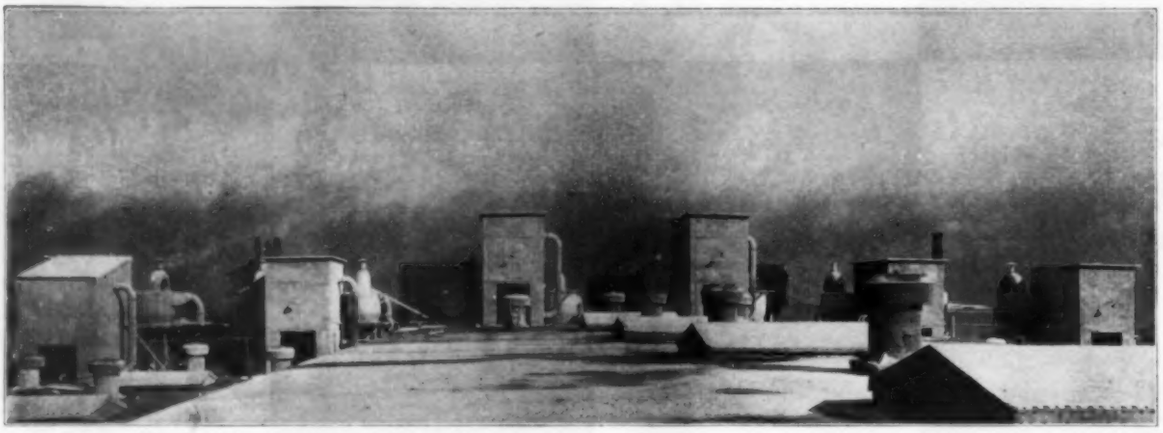
You can use **DURIRON** *for many purposes, of some of which you may not have been aware. It would be profitable for you to have a complete set of Bulletins.*

DURIRON



BEFORE—
A NUISANCE

Clouds of phosphate dust created a nuisance here that only Dracco filters were able to eliminate. The exceeding fineness of the dust, 84% thru 300-mesh screen, caused it to elude all previous control attempts.



AFTER—
AN ASSET

Contrast this condition with that above. Here no dust is visible—its absence represents complete elimination of a nuisance and a product recovery averaging a ton each day.

Changing a Dust Nuisance into an Asset

The ability of Dracco High Efficiency Filters to clear up the most obstinate dust conditions is demonstrated again in this installation.

Once, phosphate dust from the vents of twelve pulverizers was a constant source of nuisance to the neighborhood, created unhealthful working conditions and wasted valuable dust.

Today, with a bank of six Dracco filter units no dust discharge is visible. Troublesome dust discharge is completely eliminated and .2 per cent of total mill capacity is recovered to contribute to the over-all efficiency of the plant.

Throughout the process fields—wherever dust and fumes create a nuisance, a health hazard or a loss of material—Dracco installations are proving the solutions to the problems.

Dracco engineers will gladly advise with you on the solution of your similar problems.

DRACCO

THE DUST RECOVERING & CONVEYING CO.

Engineers and Manufacturers **CLEVELAND, OHIO**

AIR FILTER FOR TREATMENT OF *Pollenair* TRADE MARK **HAY FEVER AND POLLEN ASTHMA**

Hydraulic valve lubrication insures effective manipulation

High pressure lubrication prevents valve leakage by application of the Nordstrom principle. Nordstrom Valves prevent leaks and stay tight after long service. A force several times that of the line pressure is used to force viscous "Merco" lubricant into every pathway of leakage, thereby sealing the valve effectively from further leakage. The seat and plug surfaces are renewed completely by making use of the proper lubricants. At the same time pressure lubrication performs the other functions of a hydraulic jack when necessary to loosen the plug when stuck and so reduces the coefficient of friction on sliding metal surfaces held together under high pressure. Furthermore, Nordstrom Valves effectively combat corrosion and erosion when used as a stop in the pipe line. None of the vital parts are exposed to disintegrating forces of the fluid. We strongly recommend the use of "Merco" lubricants. Ask for Catalog.

MERCO NORDSTROM VALVE COMPANY
SUBSIDIARY OF THE MERRILL COMPANY . . ENGINEERS

Atlanta - Healy Bldg.
Boston - 184 Boylston St.
Buffalo - Genesee Bldg.
Charleston - 304 Capitol St.
Chicago - 176 W. Adams St.
Dallas - Magnolia Bldg.
Detroit - 2842 West Grand Blvd.
El Paso - 111 So. Virginia St.
Houston - Petroleum Bldg.
Los Angeles - 566 So. San Pedro St.
New Orleans - Masonic Bldg.
New York - 11 W. 42nd St.
Pittsburgh - Clark Bldg.
St. Louis - 317 N. Eleventh St.
San Francisco - 343 Sansome St.

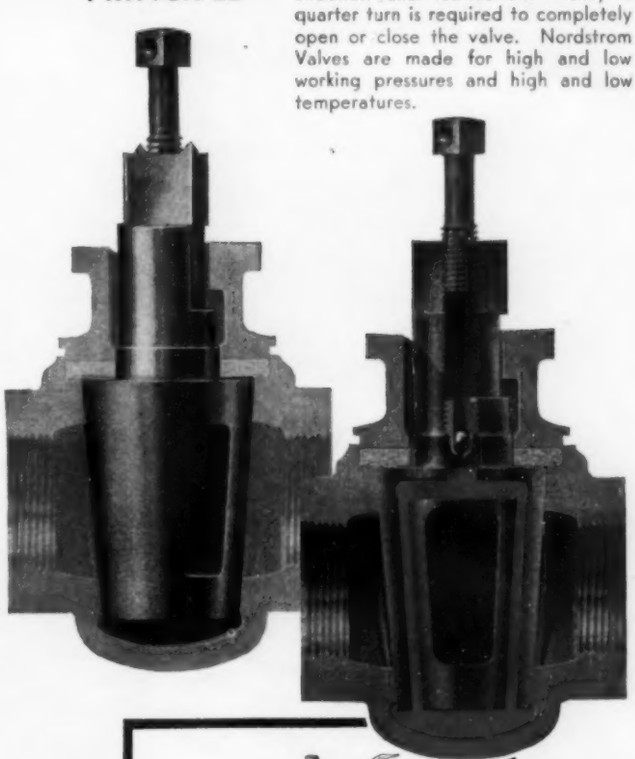
Agencies:

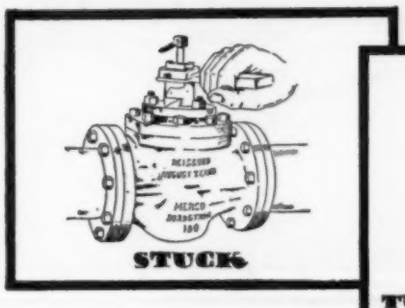
Denver - Republic Supply Company, 332 Continental Oil Bldg.
Honolulu - W. A. Ramsay Co., Ltd., Fort & Queen Streets
Manila - E. W. Sharp c-o J. A. Murphy Co. Peres Semasillo Bldg.
Philadelphia - Brown, Wilson & Company, 1600 Arch St.
Saginaw - Arthur C. Beckert, 112 Durand St.
Salt Lake City - National Equipment Co., 101 West 2nd South St.
Tulsa - B.V. Emery & Company, 216 E. Brady Street

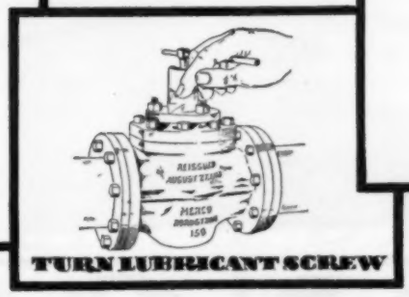
Factories in U. S. Oakland, Calif. and Belleville, N. J.
Canada - Peacock Bros., Ltd., Montreal, Toronto, Winnipeg, Vancouver. (Also Sydney, N.S.)
England - Audley Engineering Co., Ltd., Newport, Shropshire.
Buenos Aires, Argentine, - General Electric, Soc. Anon., Victoria 618 Esq. Peru.

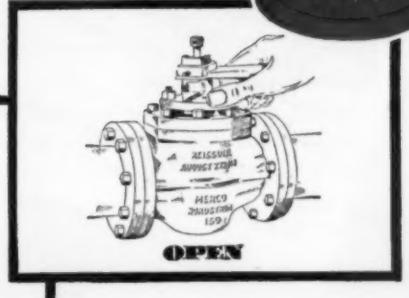
THE PERFECT APPLICATION OF A PRINCIPLE

The phantom views shown below illustrate the plug cock principle of construction and lubrication. Only a quarter turn is required to completely open or close the valve. Nordstrom Valves are made for high and low working pressures and high and low temperatures.









MERCO

Nordstrom Valves

Don't Lock Out Ideas

Business is Good for those who make it so

A RECENT survey of a dozen typical plants afforded considerable surprise. Four are 28% ahead of last year. Eight averaged 18% ahead. Business is good for those who make it so. This has been accomplished

by using all the energy in every department
—improving products—improving processes
—improving plants;
in short—

by utilizing every modern aid to cut selling and production costs.

Marked improvement can be made in your business by a careful, close-up study of all that is new and most modern in process development machinery, methods and equipment. A visit to the Chemical Industries Exposition, Grand Central Palace, New York, during the week of May 4th will be a profitable investment for you and your firm.

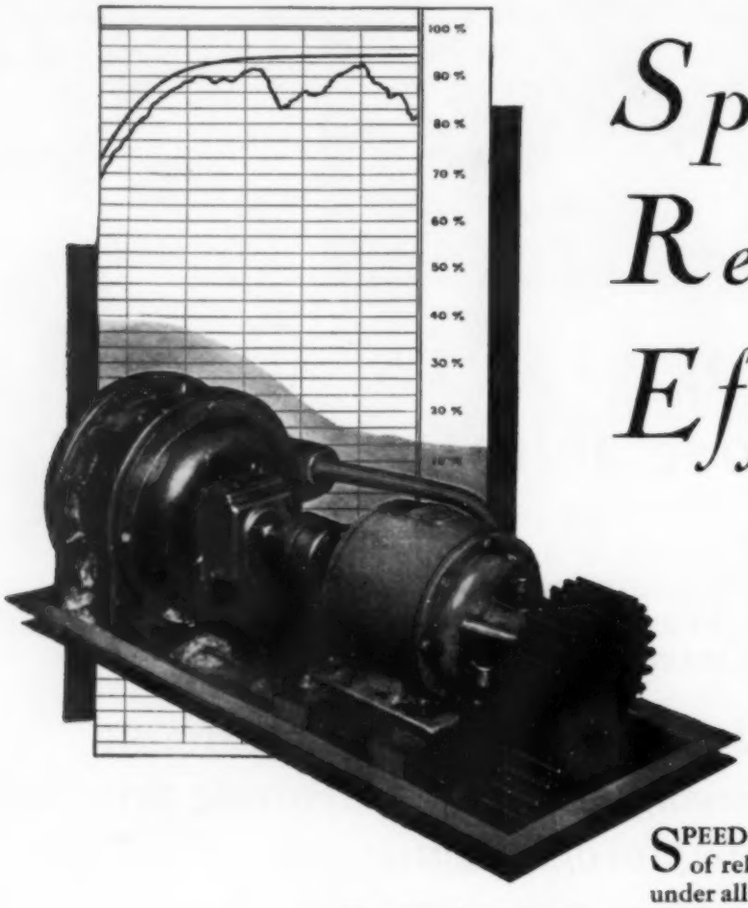
Mr. Manufacturer:
Your greatest opportunity to meet, in the biggest market place of the Chemical Industries, an audience of buyers is offered in this Exposition. Applications for space should be made at once to Room 701, Grand Central Palace, New York, N. Y.

Thirteenth Exposition CHEMICAL INDUSTRIES

Management International Exposition Company

5173B

How Do You Measure



Speed Reducer Efficiency?

SPEED Reducer efficiency is a matter of reliable, unvarying performance under all conditions of speed and load. Sharp peaks and valleys in operating efficiency caused by heat, friction, shock or overload mean increased power consumption and possible damage to motor or driven machine.

G & F Speed Reducers, when used as recommended by our engineers, will give highly efficient and unvarying performance under all reasonable conditions of operation. Their point of highest efficiency is quickly reached and continuously maintained. Due to proper mounting and careful alignment of gears and shafts, friction and heat are practically eliminated. Bearings and shafts are of ample size to carry heavy overloads. Gears are accurately cut from forged blanks supplied by our own forge division.

Let our engineers recommend the size and type of Speed Reducer, Worm, Planetary, or Herringbone, that will give you the most efficient service. Our line is complete . . . you may rely on our unbiased recommendation.

G & F Products

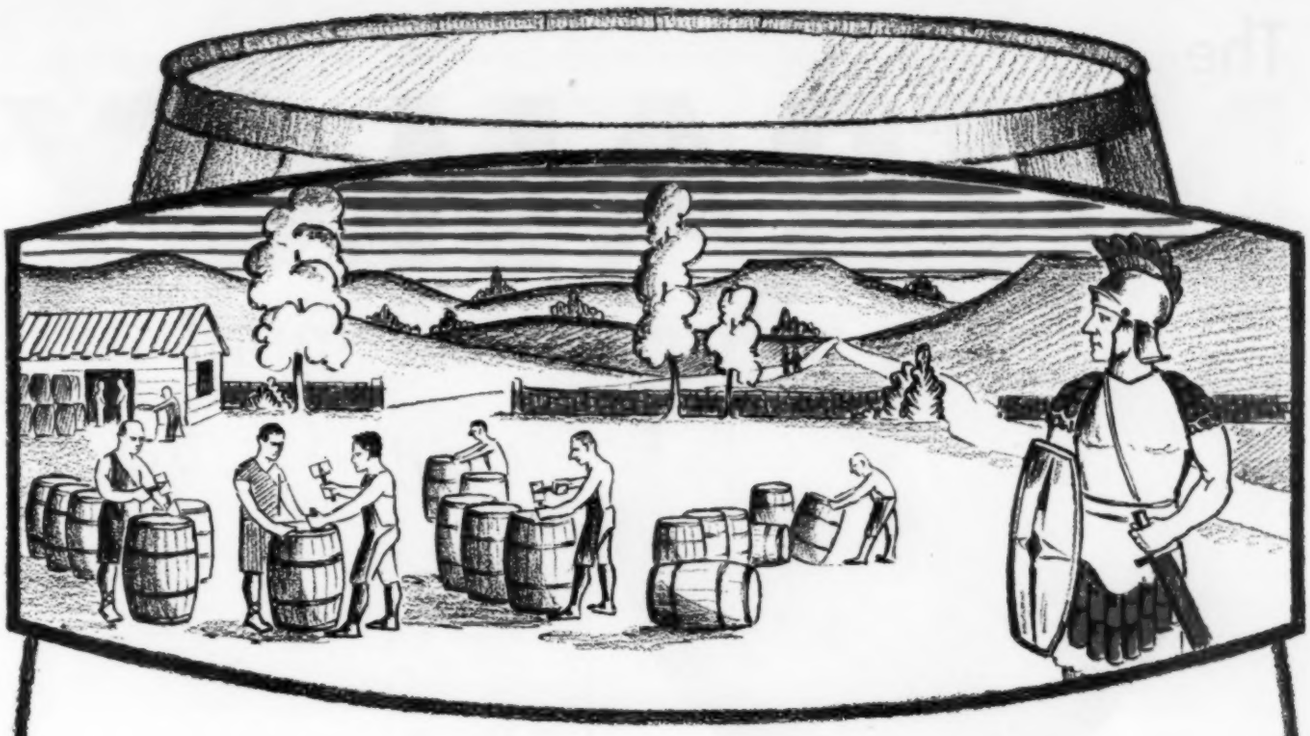
Drop, Flat Hammer and Upset Forgings
Cut Gears
Speed Reducers
Rolling Mill Machinery
Special Machinery
Bridge Operating Mechanisms

GEARS AND FORGINGS, INC.

GENERAL OFFICES: 3016 WOODHILL ROAD, CLEVELAND, O., U. S. A.
District Offices: Chicago, Detroit, Buffalo, New York, Milwaukee, Indianapolis, Pittsburgh. *Factories:* Cleveland, Chicago, Ford City, Pa.

GEARS AND FORGINGS INC.

SPEED REDUCERS



Efficient Protective Containers since the First Century:

WOODEN BARRELS

The economy and efficiency of the WOODEN BARREL as a container was recognized even by the ancients. The historian, Pliny, refers to the use of the wooden barrel by the inhabitants of the Alpine Valley as early as 100 A.D. and attributes the invention of cooperage to these peoples.

And down to today no container is so universally appreciated for its strength, ease of handling, and its efficiency in protection.

Packed in the clean WOODEN BARREL your product, — liquid, semi-liquid, dry or powdered,—reaches its destination safely. It is protected in transit or in storage from siftage, atmospheric changes, damage or contamination.

The wooden barrel is the only container that conforms to the "double arch" type of construction. Made up as it is of staves bound together by external pressure, no container is so resilient, distributing and modifying the force of shocks throughout its entire structure. Freight claims are eliminated and the customer saved the annoyance of damaged or missing goods.

The Associated Cooperage Industries of America is prepared to give you data with reference to any packing problem without obligation.

THE
ASSOCIATED COOPERAGE INDUSTRIES
OF AMERICA

Railway Exchange Building, St. Louis, Mo.

WOODEN BARRELS

The NITRALLOY movement of this Gauge

The Ashcroft American DURAGAUGE is made in sizes from 4½" to 16", for all pressures up to 5000 lbs., in Wall Mounted case, Flush Mounted and Flush Mounted Illuminated cases.

. . . outlasts a Hundred others

SIX months ago the nitralloy movement of one of our new Ashcroft American DURAGAUGES was connected to a small compressed air hammer vibrating at about 1500 cycles per minute. At the same time the movement of a commercial gauge was attached to the same hammer in the same way.

The hammer has been vibrating 24 hours a day ever since. The nitralloy movement still shows no sign of wear, but the other gauge movement has been replaced successively by a hundred others . . . . including movements taken from every make of gauge. The average length of life of an ordinary bronze movement was 75 minutes under this severe test. By that time the teeth were worn almost bare.

These movements have, in every instance, literally gone to pieces before being replaced . . . . but the new Ashcroft American nitralloy movement remains in perfect condition.

Frankly, we don't know how long it *will* last! But consider what this means to you . . . . here at last is a gauge with a practically indestructible movement; a gauge that is made to last forever.

The Ashcroft American DURAGAUGE is unconditionally guaranteed for five years, and to be accurate within one-half of 1% over the entire scale range. Such a gauge could only be produced by a Company with a background of eighty years of gauge manufacturing experience. Write today and get the complete story.

CONSOLIDATED ASHCROFT HANCOCK CO., INC.
Bridgeport, Conn.
Subsidiary of Manning, Maxwell & Moore, Inc.

CONSOLIDATED ASHCROFT HANCOCK

ASHCROFT AMERICAN DURAGAUGE

Specify Catalogs Desired:

American Dial Thermometers	G-4	American Recording Gauges	E-4	Consolidated American Safety and Relief Valves	Z-4
American Glass Thermometers	F-4	American Draft Gauges	B-4	Hancock Bronze Valves	WB-4
American Recording Thermometers	H-4	American Gauge Testers	D-4	Hancock Cast Steel Valves	WA-4
Ashcroft American Gauges	A-4	American Tachometers	J-4	Hancock Forged Steel Valves	W-4
American Temperature Controllers	R-4	Ashcroft Power Control Valves	M-4		

THE 3RD ORDER

SMITHWelded Retorts of Stainless Steel, of the type shown here, have been built on three successive orders in various quantities for the Newport Company, manufacturers of dyes and chemicals.

Several years ago A. O. Smith Corporation built the first SMITHWelded Autoclave for this Company. Since then they have ordered a great variety of additional SMITHWelded vessels.

A. O. SMITH CORPORATION
General Offices: Milwaukee, Wisconsin
PRESSURE VESSEL DIVISION

SMITHWELDED

THERE ARE NOW MORE THAN 1500 IN SERVICE

FOR SMITHWELDED STAINLESS STEEL RETORTS FOR THE NEWPORT COMPANY

PRESSURE VESSELS

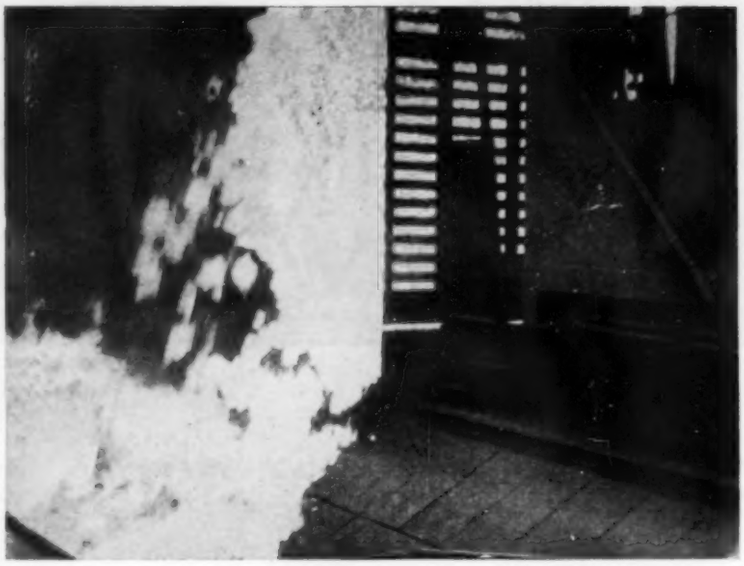
OPERATING PRESSURES UP TO 5000 POUNDS

KOPPERS COKE OVENS

•

KOPPERS BUILDS

BECKER OVENS
BENZOL PLANTS
GAS PRODUCERS
BY-PRODUCT PLANTS
MATERIAL HANDLING PLANTS
PHENOL RECOVERY PLANTS
ETC.



DOMESTIC COKE

The very fact that house heating is a vexing winter problem offers a splendid opportunity for coke, the moderately priced, clean, thoroughly satisfactory fuel. Coke benefits the community and the individual; and customers won for coke form a permanent and stable market.

Koppers plants play a large part in making and keeping coke customers. In the design of these plants, no detail is overlooked which will assure customer good-will.

•

WRITE FOR BECKER OVEN CATALOG

•

KOPPERS

CONSTRUCTION COMPANY

PITTSBURGH, PA.

Use CALDWELL'S Experience In Applying Spiral Conveyors

Helicoid Screw Conveyor Installation

Sectional Flights

Helicoid or Continuous Flight Conveyor

A BACKGROUND of over fifty years' experience in designing, manufacturing, and applying spiral or screw conveyors, enables Caldwell to submit time and money saving suggestions concerning the best practice in installing and operating spiral conveyors.

Both the sectional flight conveyor units and the continuous flight or Helicoid conveyor—originated by Caldwell years ago—have their places in the conveying art. As manufacturers of all types of conveying equipment, Caldwell is free to recommend whatever equipment long experience has proved to be most effective for the work.

There is no obligation in asking Caldwell engineers to submit their recommendations, whether minor changes in present equipment, or a complete new installation is involved. For detailed information address

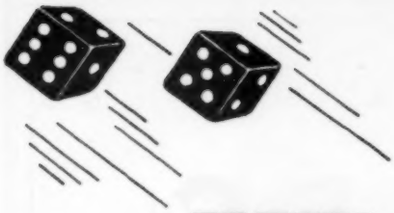
H. W. CALDWELL & SON CO.
DIVISION, LINK-BELT COMPANY
CHICAGO, 2410 West 18th Street
NEW YORK: 2676 Woolworth Bldg.
DALLAS: 1101 Mercantile Bank Bldg.
Offices in Principal Cities

C-152

Typical Caldwell Screw Conveyor Installation

CALDWELL

CONVEYORS · · ELEVATORS · · POWER TRANSMISSION EQUIPMENT



WHY GAMBLE?

If a machine or method is not dependable as to *results* you gamble on *quality*; if it is not *productive* you gamble on *profits*.

Fletcher Centrifugal Extractors are absolutely dependable as to uniformity of output . . . users everywhere will tell you that. And we are ready to prove that Fletcher Centrifugals can lower *your* processing costs by increasing output and reducing labor costs.

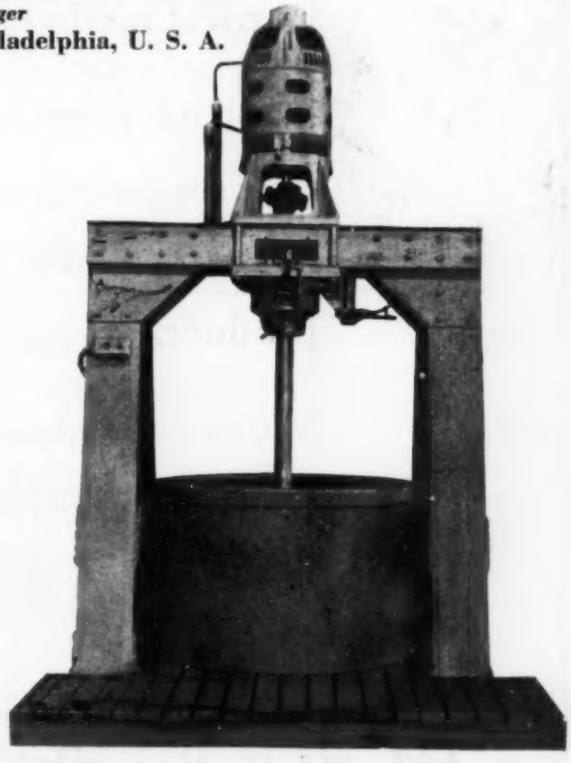
Fletcher Centrifugals, for separating solids from liquids, for clarifying, for drying, for every industry and every process. Let us tell you about them . . . *show what they can do for you.*

FLETCHER WORKS, INC.

Formerly Schaum & Uhlinger

Glenwood Avenue at Second Street, Philadelphia, U. S. A.

Established 1850



FLETCHER CENTRIFUGALS

STONEGA

STONEGA *for processing clay and brick products*

STONEGA COAL completely fulfills the exacting requirements of the industrial group which includes clay products, non-clay refractories, pottery and sand-lime brick.

Industries that produce barium salts, phosphorous salts, carbon dioxide, zinc products, coke, gas, steel, glass, lime and cement also find that STONEGA Coal is well suited for their purposes.

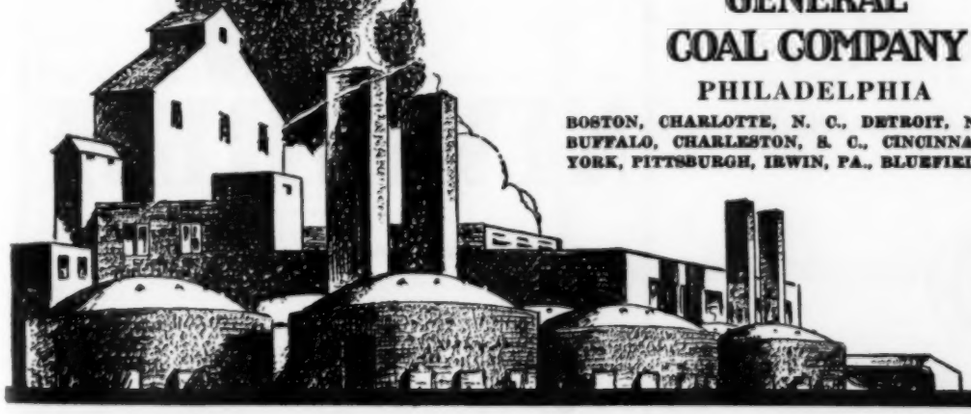
STONEGA Coal is produced by the Stonega Coke and Coal Company at Stonega, Arno, Imboden, Osaka and Exeter Mines, Imboden Seam, located in Wise County, Virginia, on the Interstate Railroad Company.

Whatever your process requirements may be, there's a General Coal to meet your need. Our nearest office will gladly consult with you about your problems.

GENERAL COAL COMPANY

PHILADELPHIA

BOSTON, CHARLOTTE, N. C., DETROIT, NORFOLK, BUFFALO, CHARLESTON, S. C., CINCINNATI, NEW YORK, PITTSBURGH, IRWIN, PA., BLUEFIELD, W. VA.



~ ~ for every process requirement ~ ~

GENERAL COAL

SELECT YOUR SILICATE of SODA

from Quartz Quality Brands. The easiest way to specify silicate is by brand names of grades. These were perfected for individual uses from experience in the manufacture and use of silicates accumulated since Civil War days.

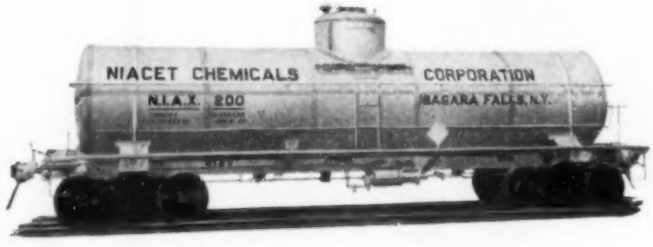
Our brands include thirty-three types of soluble silicates of soda. You are sure to get the right grade for your use from this wide selection. Furthermore, rigid standards in our laboratories and plants provide you with the same quality every time the same brand is ordered.

Let us help you choose the best grade for your particular need. If you have never tried silicate in your process, we shall be glad to submit our recommendation on request.

Philadelphia Quartz Company

General Offices and Laboratory
121 S. THIRD STREET, PHILADELPHIA
Chicago Sales Office: 205 W. Wacker Drive

NIACET ACETIC ACID



Guaranteed 99½% Pure—In Any Quantity

NIACET ACETIC ACID is of the highest quality, guaranteed to be always of uniform strength, and shipment in aluminum drums or tank cars keeps it that way. No handling loss, no breakage, no discoloration, no freight for water—our service is designed for your convenience.

Also U.S.P. Reagent Glacial Acetic Acid Guaranteed 99.8% Pure

PACKING

Aluminum Tank Cars provided with steam coils	*65,000 lbs. net*
Aluminum Drums	*900 lbs. net*
Aluminum Cans	*100 lbs. net*

NIACET CHEMICALS CORPORATION

Sales office and plant: **NIAGARA FALLS, N. Y.**

Our Products

GLACIAL ACETIC ACID
U. S. P. ACETIC ACID
ACETALDEHYDE
PARALDEHYDE
CROTONALDEHYDE
ACETALDOL
PARALDOL
"FASTAN"

A cheaper, more efficient source of HYDROGEN

A new source of hydrogen has been discovered!

By developing a simple, economical and automatic anhydrous ammonia dissociator or "cracker"* the Du Pont Ammonia Corporation has reduced the cost of hydrogen and nitrogen to users of these gases. In this apparatus ammonia gas is dissociated or cracked into its component elements when passed over an electrically heated catalyst.*

The resulting gas contains 75 per cent hydrogen and 25 per cent nitrogen by volume. This affords a convenient and economical source of hydrogen since *one* cylinder containing 100 lbs. of ammonia will yield 4500 cu. ft. of gas containing 3400 cu. ft. of hydrogen, equivalent to the volume of hydrogen contained in *seventeen* cylinders. At present prices of cylinder ammonia, the cost of hydrogen from cracked ammonia is about half that of hydrogen in cylinders. Furthermore, there is a large saving in cylinder handling costs.

Greater proportionate economies (one cylinder of anhydrous ammonia equivalent to thirty-nine cylinders of nitrogen) can be effected if the product desired is

NITROGEN!

A POSSIBLE 50% SAVING IN YOUR HYDROGEN COSTS. ASK US FOR DETAILS

* Patents Pending

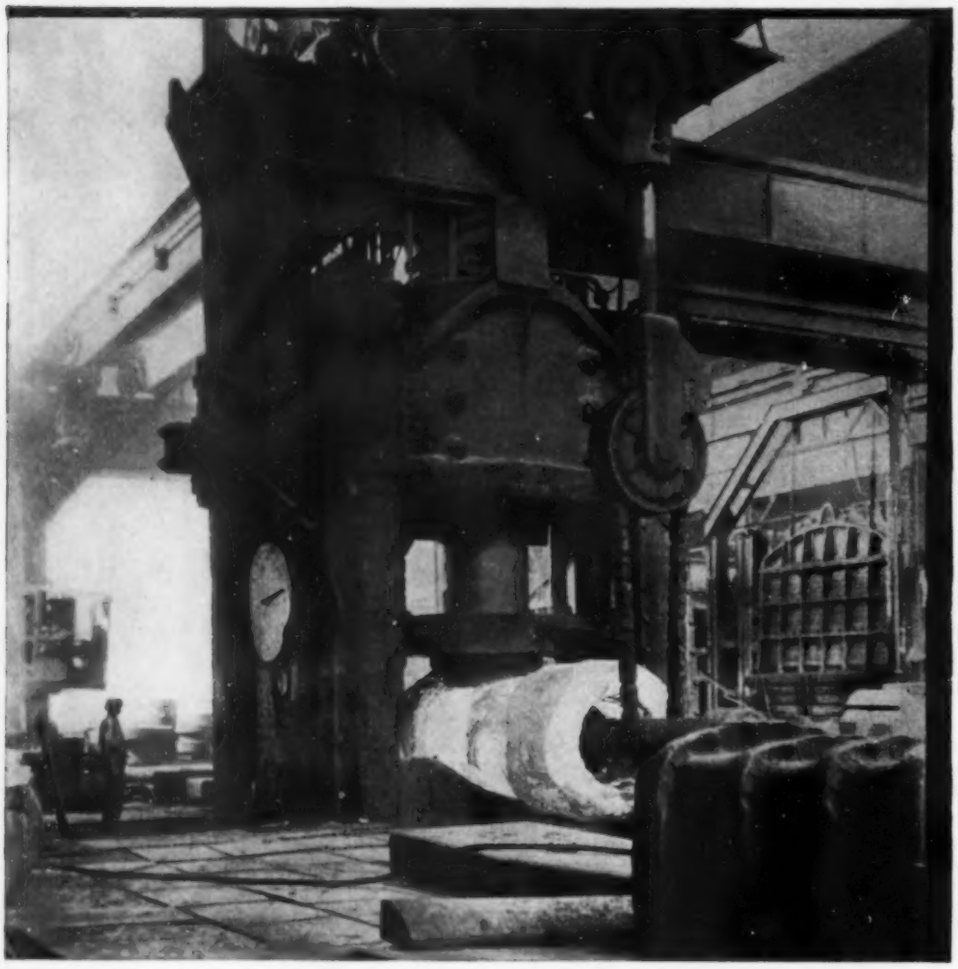
DU PONT AMMONIA CORPORATION

DU PONT
REG. U.S. PAT. OFF.

WILMINGTON, DELAWARE
PLANT: BELLE (CHARLESTON), WEST VIRGINIA

METALS-THE BASIS OF BETTER EQUIPMENT

FORGED
FROM A SINGLE INGOT



NO seams, no joints where there might be a question mark instead of a known factor—Midvale forges *seamless* pressure vessels, made from a single steel ingot!

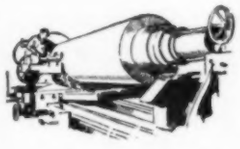
Builders and operators of high pressure cracking units are interested in the strongest, the safest type of vessel that can be produced. Midvale was a pioneer in this type of vessel, and Midvale's research laboratory and experienced shop men continue to carry pressure vessels' capacity to higher limits—over wide ranges of diameters, lengths and wall thicknesses.

The Midvale Company is at your service at any of its offices—Philadelphia, New York, Washington, Pittsburgh, Cleveland, Chicago or San Francisco.

MIDVALE

MIDVALOY HR

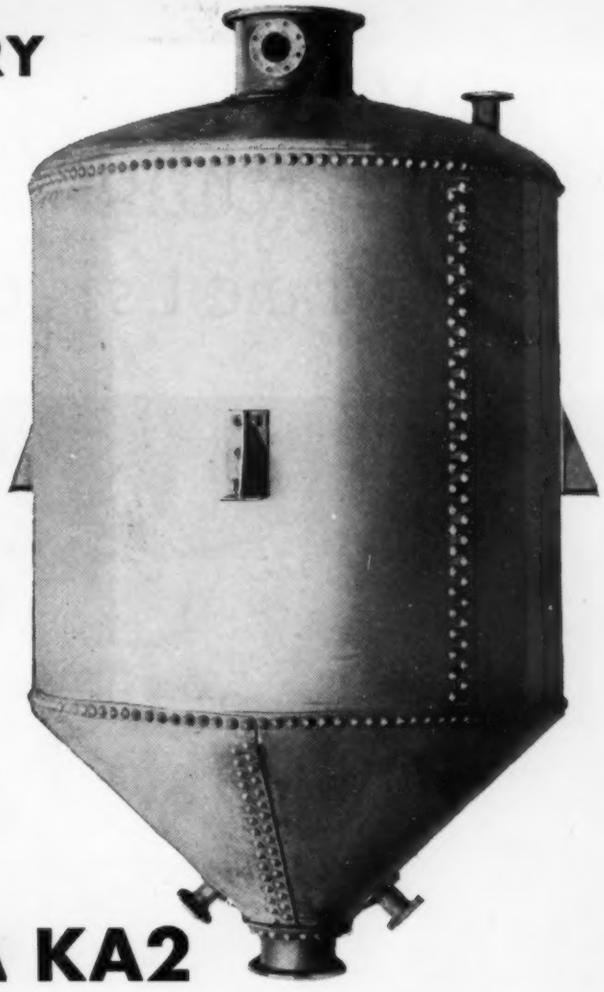
Midvaloy H R fits a surprising number of needs. Its heat-resistant and corrosion-resistant qualities make it both efficient and economical for high temperature operating conditions. Successful installations with Midvaloy H R include: continuous furnace parts, retorts, boxes, recuperator tubes, stoker grates, tuyeres, chains, slicing links, sulphide roasting furnace parts, oil refining furnace parts, cast pyrometer tubes and gas industry equipment.



TOOL STEEL

Midvale does not follow the "tonnage" method of tool steel production. Midvale charges with cold metal. Lets the ingots cool, to permit inspection for faults. Carefully chips out any cracks. Reheats ingots and reduces billet size. Sand-blasts the scale. Again inspects and chips when necessary. Reheats and rolls to finished size. This is the only method by which tool steel of Midvale quality can be produced.

THE CHEMICAL INDUSTRY TURNS TO... ENDURO for corrosion control



ENDURO NIROSTA KA2

... *the perfected stainless steel*

ENDURO NIROSTA KA2, the perfected alloy processed according to patented Krupp specifications, is resistant to a wider range of corrosive media encountered in the chemical and process industries, than any other alloy.

■ Some indication of the trend toward this improved alloy of high-strength and ductility is gained from its rapidly growing applications where corrosion is most severe. Acid shipping drums, cracking still tubes, digesters, condensers, storage tanks, acid piping, and countless other chemical plant equipment is now fabricated from ENDURO.

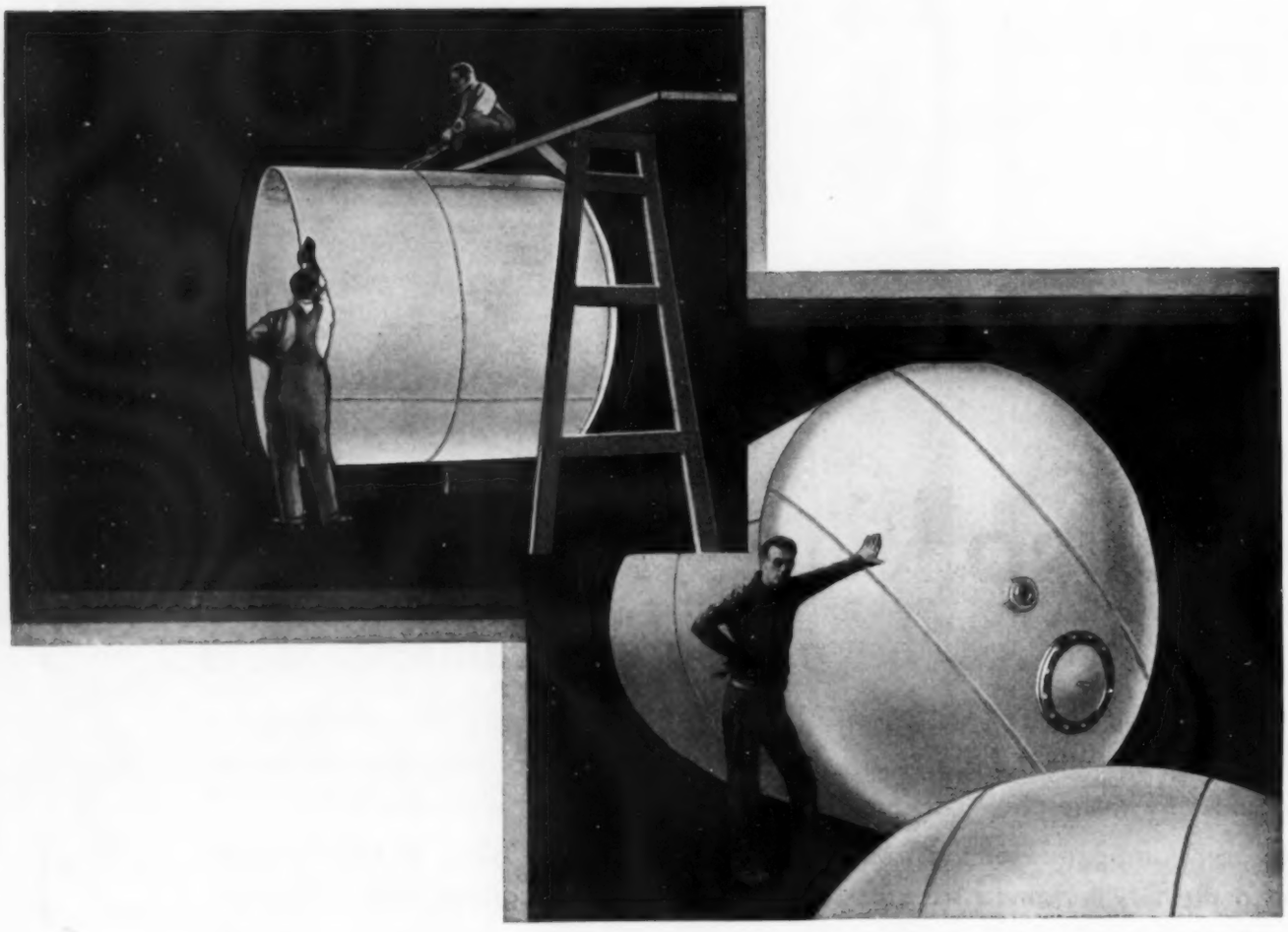
■ Wherever corrosion now necessitates frequent replacements, ENDURO NIROSTA KA2 may provide corrosion control. Why not investigate this possibility now? Republic engineers will be glad to discuss any corrosion problem with you.

Central Alloy Division

REPUBLIC STEEL
CORPORATION
Massillon, Ohio

Welding Alcoa Aluminum

. . . . facts of importance



A FORTUNATE combination of chemical and physical properties makes Alcoa Aluminum an excellent container and structural material for use in the many different industries that process chemicals.

FULLY FABRICATED EQUIPMENT OF

ALCOA

and its strong Alloys . . . . to the chemical engineer

Alcoa Aluminum and its strong Alloys possess high structural strength, yet are extremely light in weight. Other metals commonly used weigh from 2½ to 3¼ times as much as Alcoa Aluminum. Available in sheets, rods, tubes, castings and extruded shapes, Alcoa Aluminum is easily fabricated.

Where the apparatus is of intricate design, the fact that Alcoa Aluminum can be readily and satisfactorily welded is a distinct advantage. In the hands of an experienced welder, the process of fusion welding is simple and rapid. It can be applied to metal of all thicknesses. The joint is not unsightly and can be finished off so that it cannot be detected.

The same type of weld, butt, lap, tee, fillet, etc., made with anv other metal, is also made in Alcoa Aluminum. Torch welding is applicable both to the manufacture of articles from sheet Alcoa Aluminum and to the repair of Alcoa Aluminum Alloy castings.

In welding Alcoa Aluminum and its light, strong Alloys, it is preferable to use an oxy-hydrogen flame wherever it will supply sufficient heat. On a given gauge of sheet, a larger tip is used for hydrogen than for acetylene.

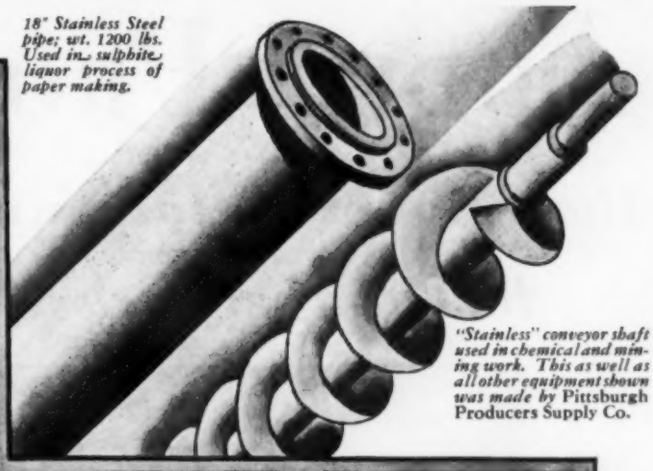
Whether using hydrogen or acetylene, the torch should be carefully adjusted to show a neutral flame, since this gives the best speed and economy, as well as a cleaner, sounder weld.

The booklet, "The Welding of Aluminum", gives complete data on this phase of working aluminum. It gives information on torch welding. It discusses the welding apparatus needed. It gives a table of the approximate size of tips and relative gas pressures to use in welding aluminum of different thicknesses. It gives six pointers on flux. It supplies data on the tensile strengths of welded and unwelded tubing. May we send you a complimentary copy? Address ALUMINUM COMPANY *of* AMERICA; 2451 Oliver Building, PITTSBURGH, PENNSYLVANIA.

▼ ▼ ▼

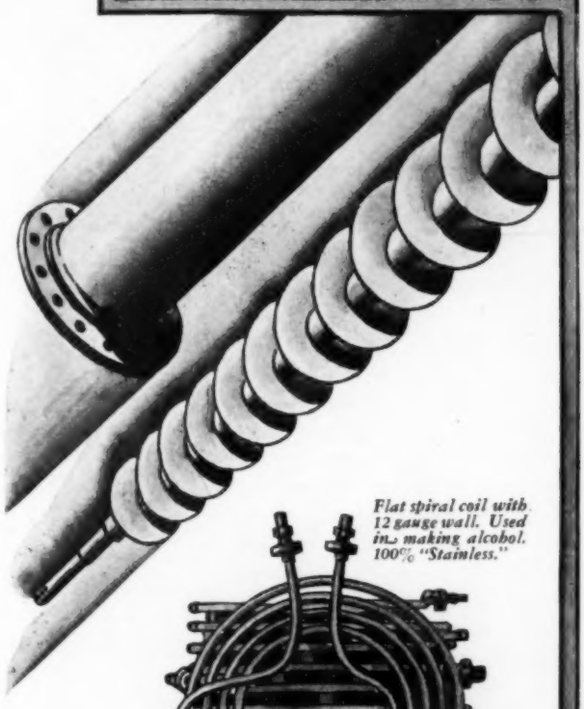
ALUMINUM

TO ELIMINATE WASTE



18" Stainless Steel pipe; wt. 1200 lbs. Used in sulphite liquor process of paper making.

"Stainless" conveyor shaft used in chemical and mining work. This as well as all other equipment shown was made by Pittsburgh Producers Supply Co.



Flat spiral coil with 12 gauge wall. Used in making alcohol. 100% "Stainless."

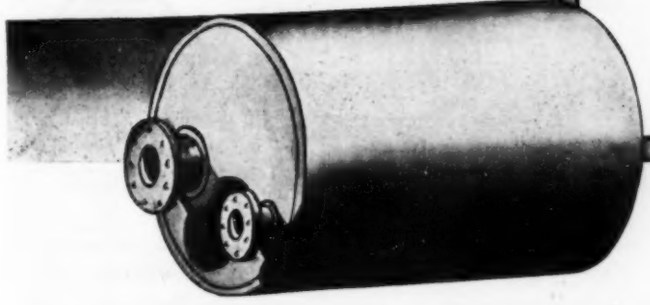
Stainless Steel tank 4x6 feet made for oil refinery use.

CORROSION costs the Process Industries millions of dollars each year. This is an absolute waste which Stainless Steel will positively prevent.

Larger and larger grows the volume of "Stainless" entering the Process Industries . . . The ultra-conservative mechanical department that "couldn't handle" Stainless Steel *now* has to handle "Stainless" in order to meet competition. Stainless Steel is too basically economical to be disregarded . . . It can and will be used, eventually, in your equipment . . . Its tremendous advantages; corrosion, wear, heat, pressure, abrasion and erosion resistance are discussed in our booklet "Stainless in Industry" . . . Write for it.

Genuine Stainless Steel is manufactured only under the *patents* of AMERICAN STAINLESS STEEL COMPANY . . Commonwealth Building, Pittsburgh, Pennsylvania.

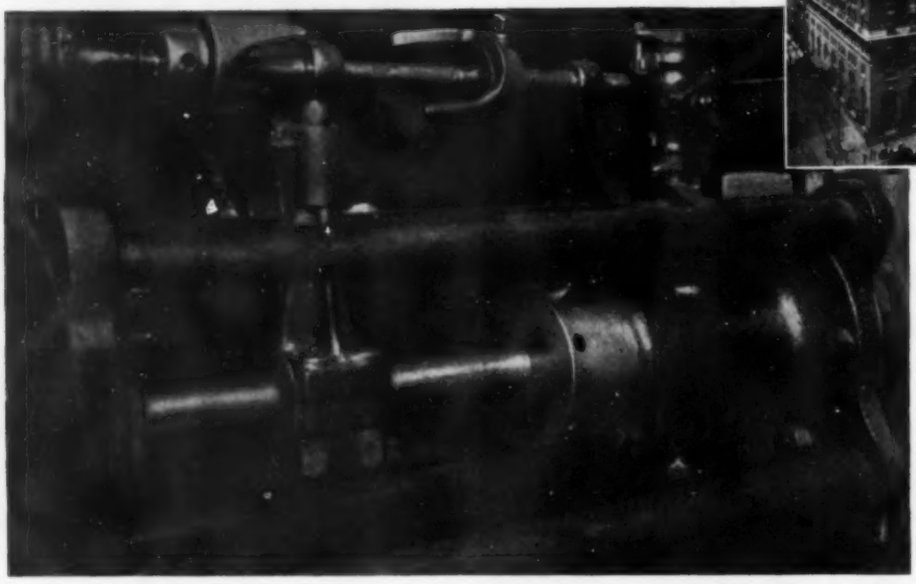
STAINLESS STEEL



"Stainless" agitator blade 8 ft. long . . . Used in mixing special chemicals.

ADDED PROOF...

that Monel Metal pump rods last longer...save repairs



Above:
Exterior of La Salle Hotel, Chicago, Ill.

At left: *Close-up view of Monel Metal pump rod on ammonia compressor pump in refrigerating department of La Salle Hotel.*

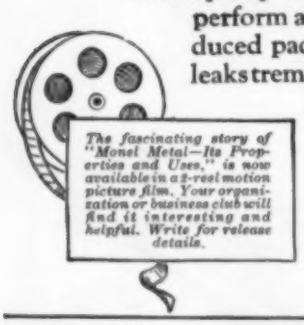
WHEN industrial pump equipment fails to deliver dependable performance—production suffers. When institutional pump equipment lies down on the job—*people* suffer. Convenience and comfort depend on the smooth, uninterrupted flow of power that generates light, produces heat, develops water pressure and drives refrigeration and ventilation units.

That is why modern hotels, like Chicago's famous La Salle, are so careful in their choice of pump equipment—particularly pump *rods*.

G. O. Frame, Chief Engineer of the La Salle Hotel, testifies that Monel Metal pump rods far outwear and outperform all others. They have reduced packing losses and gland leaks tremendously. "We average better than 12 months' service with no attention whatsoever," he says.

Such exceptional performance is attributable to properties which only Monel Metal possesses: immunity to rust; high corrosion-resistance; rigidity and toughness of steel; absolutely uniform forged and rolled structure. Consequently, Monel Metal rods won't pit, they wear slowly, retain their roundness and acquire a high-polish surface that is nearly frictionless.

Monel Metal pump rods are available in all sizes up to 3" diameter by 1/16" steps. Our engineers will gladly show you how they will lower costs and accelerate production in your plant. Complete details of sizes, stocks and machining instructions on request.



The fascinating story of "Monel Metal—Its Properties and Uses," is now available in a 2-reel motion picture film. Your organization or business club will find it interesting and helpful. Write for release details.

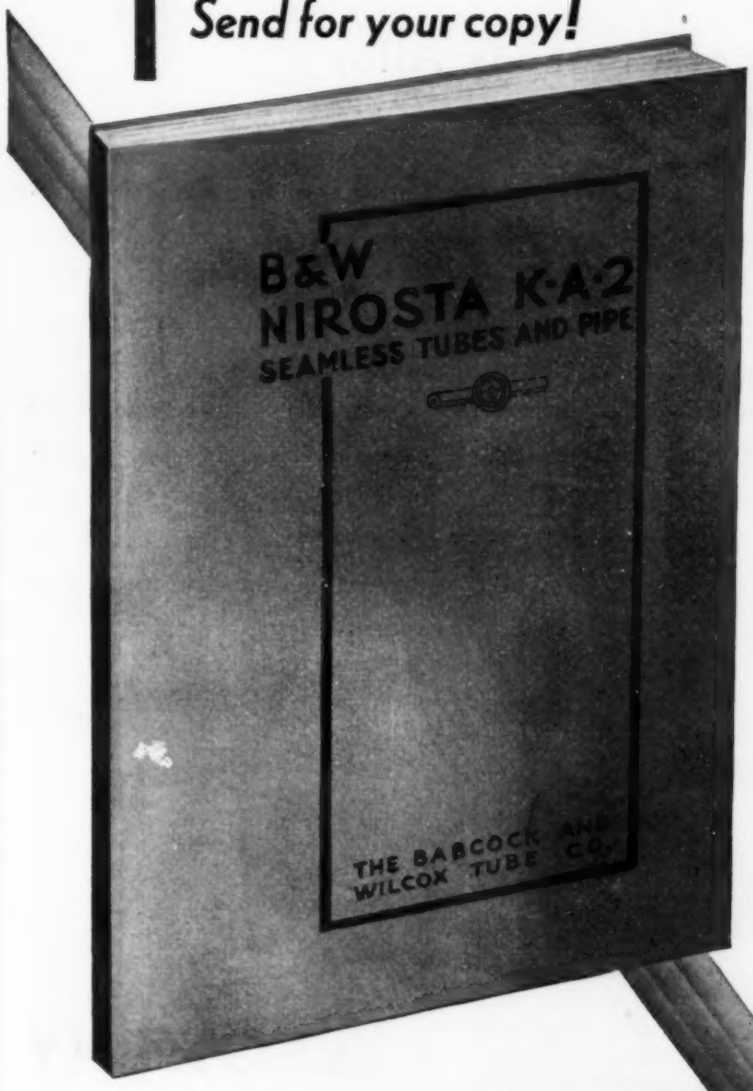
MONEL METAL

Monel Metal is a technically controlled Nickel-copper alloy of high Nickel content. It is mined, smelted, refined, rolled and marketed solely by The International Nickel Company. The name "Monel Metal" is a registered trade mark.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

This SECOND Edition is now ready for distribution

Send for your copy!



SINCE the publication of the first edition of this booklet in 1929, the use of B & W Seamless NIROSTA KA2 has been so wide as to provide a wealth of new information on this alloy.

The SECOND edition, which is now ready for distribution, contains this new information; consisting in part of actual operating data, photographs of many diversified installations, revised engineering text, and data on the distinctions made between NIROSTA KA2 and KA2S.

If you are now using NIROSTA KA2 or other stainless alloys, or if you are contemplating their use in manufacture or processing, this new booklet which contains information available from no other source, will prove of inestimable value to you. Write for a copy.

NIROSTA KA2

THE
BABCOCK & WILCOX TUBE COMPANY

BEAVER FALLS PENNSYLVANIA

HIGH HEAT and CORROSION gnaw at its vitals . . yet it NEVER FLINCHES

It's made of an Allegheny Alloy . . . cuts down replacement costs

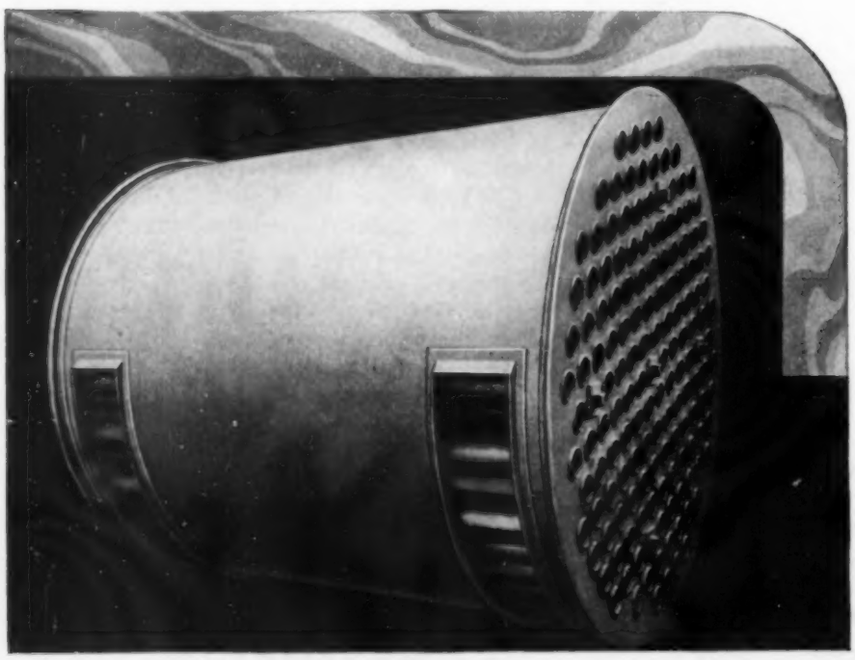
HAVE this and other Allegheny Alloys working for you.

They withstand all but a few corrosive agents . . . have excellent high heat resistance and a longer life. Allegheny Alloys speed up production. There is one for every purpose.

Where you need an unrusting, unstaining, untarnishing alloy, stronger than mild steel, choose Allegheny Metal. When you need a metal to withstand progressive corrosion, where surface discoloration is not a factor, Ascoloy 33 will meet your needs. For extreme heat resistance (to 2100 degrees F.) Ascoloy 44 will be easy to fabricate and will serve well. For simple fabrication and 2150 degrees F. heat resistance, Ascoloy 55 is best.

Find out today how these alloys can be used to make your equipment save you money. Write or wire us for Data Bulletins. These bulletins tell you the characteristics of each alloy.

Better yet . . . have one of our men call. He'll be glad to talk over your problems with you. That's why we're here . . . to see that you get the right metal to do your job best.



GREATER RESISTANCE *to heat and corrosion. Heat Exchanger—tubes and tube sheets made from Ascoloy 44. Shell and baffles made from Ascoloy 66. Exchanger to withstand up to 1800 degrees F. Fabricated by Alloy Welding and Manufacturing Co., Pittsburgh, Pa.*

Allegheny METAL

ALLEGHENY METAL

Licensed by the Chemical Foundation, Inc., under basic patents No. 1,316,817 and No. 1,339,378

ALLEGHENY STEEL COMPANY

Brackenridge, Pa. . . . *Offices:* New York, Buffalo, Chicago, Cleveland, Detroit, St. Louis, Milwaukee, Los Angeles. *Warehouse Stocks:* Joseph T. Ryerson & Son, Inc.—Chicago, Cleveland, Milwaukee, St. Louis, Cincinnati, Detroit, Buffalo, Boston, Jersey City, Philadelphia. *In Canada:* Samuel & Benjamin, Ltd., Toronto

A NEW NAME
for a widely established product

Nevastain is the new name given to the Nirosta and Stainless Steels produced by Ludlum Steel Company, Sharon Steel Hoop Company, and Timken Steel & Tube Company.

The combination of these three outstanding steel sources, together with their banded staffs of authoritative engineers and metallurgists, places at the disposal of users of these alloys a new and most comprehensive service.

The entire resources, research findings, fabrication experience, installation knowledge and experimental laboratories, of these three companies in connection with all the standard grades of corrosion, heat and wear resisting alloys including Nevastain KA2 are now available to the industrial plants of America.

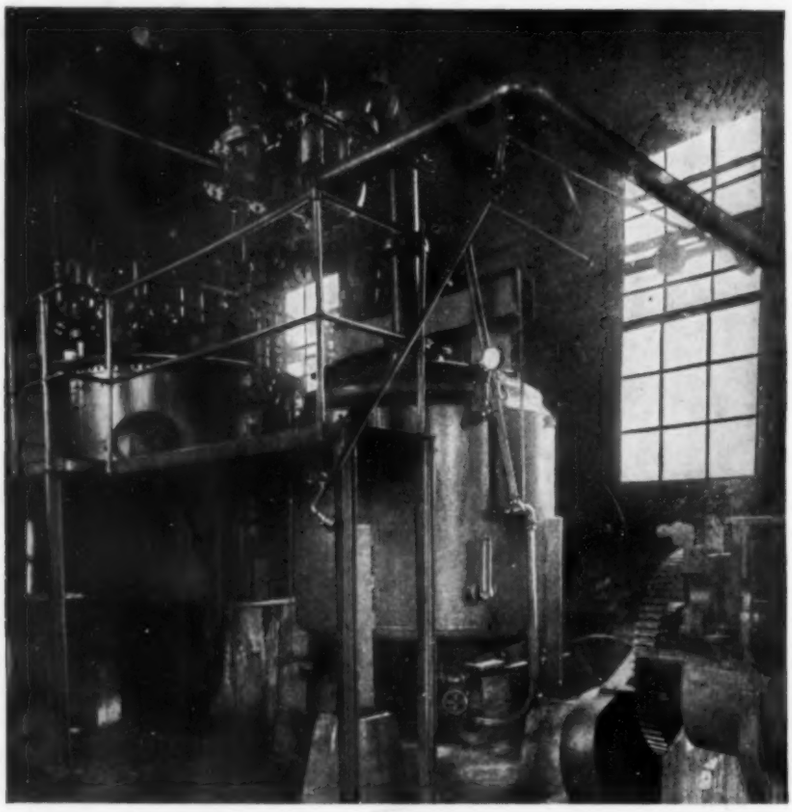
Nevastain steels are furnished by Associated Alloy Steel Company for every fabricating requirement—bars, sheets, hot and cold rolled strip, tubing, wire, welding rods, billets, slabs, plates, castings, etc.

Nevastain Alloys are furnished under the following brand names. Write for Technical Bulletin giving complete physical properties, chemical analysis, etc.

NEVASTAIN KA2
NEVASTAIN KA2S
NEVASTAIN KA2-MO
NEVASTAIN KM-1
NEVASTAIN KNC-3
NEVASTAIN CA
NEVASTAIN CB
NEVASTAIN A
NEVASTAIN S
NEVASTAIN D
NEVASTAIN H
NEVASTAIN EZ

ASSOCIATED ALLOY STEEL CO., INC.
General Office — 1806 Union Trust Building
CLEVELAND, OHIO

Branch Offices
NEW YORK PHILADELPHIA NEW HAVEN, CONN.
CHICAGO DETROIT CINCINNATI LOS ANGELES
SAN FRANCISCO



ON KETTLES FOR EVAPORATING BENZOL

BAKELITE VARNISH PROVED MOST SATISFACTORY

Steam jacketed, closed agitated 900 gallon kettles with glass linings, are used by the Thiophene Co. for evaporating benzol as a solvent from corrosive organic sulpho acids. A metal coating on the kettles was tried, but proved unsatisfactory because the unequal contraction and expansion of steel and the metal coating caused the latter to crack and peel. The kettles were then coated with Bakelite Varnish, and baked three times. This treatment proved to be entirely satisfactory. The same material was also successfully used for sealing cracks in the glass lining. Bakelite Varnish forms a tough and durable coating, that is non-hygroscopic, and resistant to oils and most acids. It is being used for a wide variety of purposes in the process industries. Write for copy of Booklet 7V, "Bakelite Varnish".

Bakelite Engineering Service—We manufacture a wide variety of Bakelite resinoid molding materials, varnishes, lacquers, enamels, cements, and other products. Twenty years experience in the development of these materials for chemical and other uses, provides a valuable background for the cooperation offered by our engineers and laboratories.

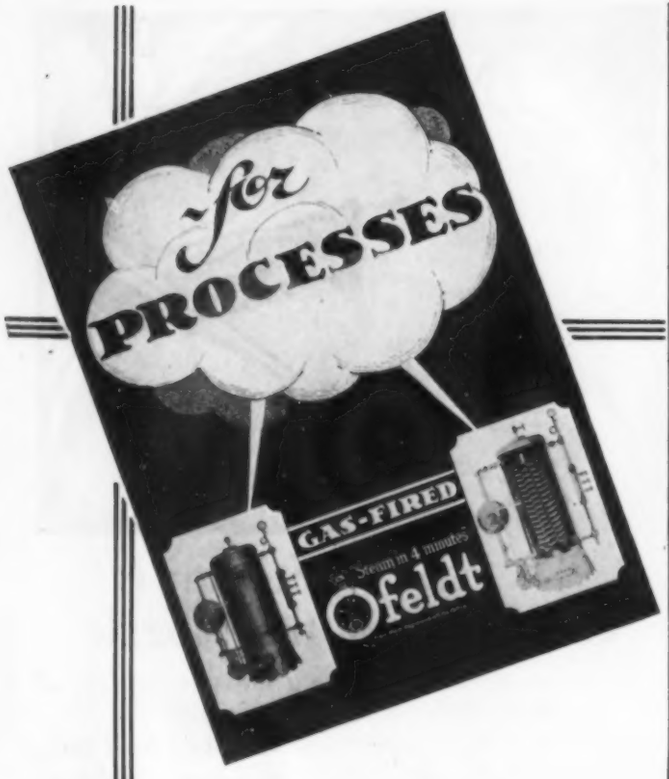
BAKELITE CORPORATION, 247 Park Avenue, New York. CHICAGO OFFICE, 635 West Twenty-second Street
BAKELITE CORPORATION OF CANADA, LIMITED, 163 Dufferin Street, Toronto, Ontario

BAKELITE

REGISTERED U. S. PAT. OFF.

"The registered Trade Mark and Symbol shown may be used only on products made from materials manufactured by Bakelite Corporation. Under the copyright "∞" is the numerical sign for infinity, or unlimited quantity. It symbolizes the infinite number of present and future uses of Bakelite Corporation's products."

THE MATERIAL OF A THOUSAND USES



CHOOSE A BOILER

that is Automatic

—for Chemical Processes, above all, you need *clean* steam in abundance at fixed pressures and temperatures. In other words, *automatic steam* from an independent process steam generator, gas-fired and fool-proof.

Steam in 4 minutes Ofeldt

Your requirements point logically to the selection of the OFELDT gas-fired automatic boiler. An Ofeldt is compact, which simplifies installation and accessibility, and eliminates long pipe lines; an Ofeldt steams faster than any other boiler of its type (4 minutes after lighting) avoiding delays and the expense of keeping up a head while the boiler is temporarily idle. Gas-firing permits *perfect* automatic control, fool-proof and dependable, and the Ofeldt is made by pioneers in automatic gas-control as applied to process boilers.

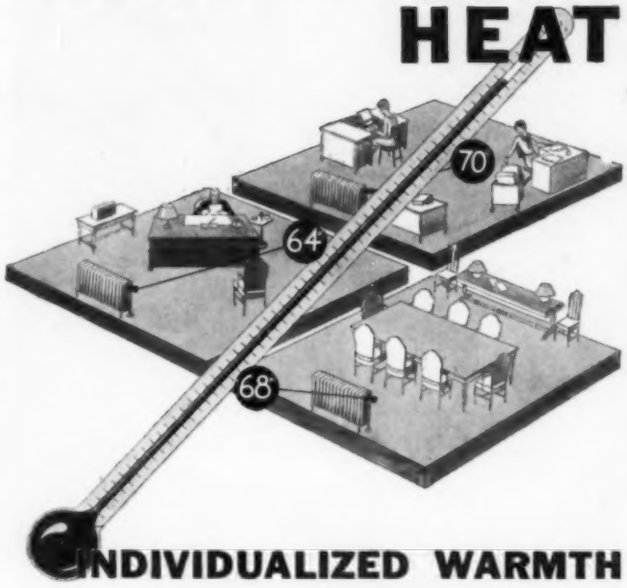
Write for Bulletin entitled,
" . . . *for* Processes."

MEARS-KANE-OFELDT INC.

1903-1915 EAST HAGERT ST., PHILADELPHIA

New York—9 Park Place
Boston—100 Arlington St.
Chicago—363 W. Erie St.
Buffalo—Waldridge Bldg.
St. Louis—2010 Locust Blvd.
Birmingham—Am. Trust Bldg.

"Made to Measure" HEAT



INDIVIDUALIZED WARMTH TO FIT EACH ROOM

Sylphon Automatic Radiator Valves assure a better general heating for any building—because they prevent fluctuating room temperatures, one common cause of fuel waste. The Sylphon Automatic Radiator Valve is made to do just one job—and does it. Sensitive to the slightest temperature changes of the surrounding air—it steadily holds the warmth of any one room at exactly the degree most satisfactory to the occupants. Once its marked thermostatic head is set at "Hot," "Medium," or "Cold" there the temperature stays. Practically the entire thermometer range of comfort may be scaled for the individual warmth selection and once set all further radiator attention is avoided. Sylphon Automatic Radiator Valves positively eliminate uneven, injurious and wasteful heat for Factory, Office Building, Apartment or Home.

A COMPLETE RADIATOR CONTROLLING DEVICE

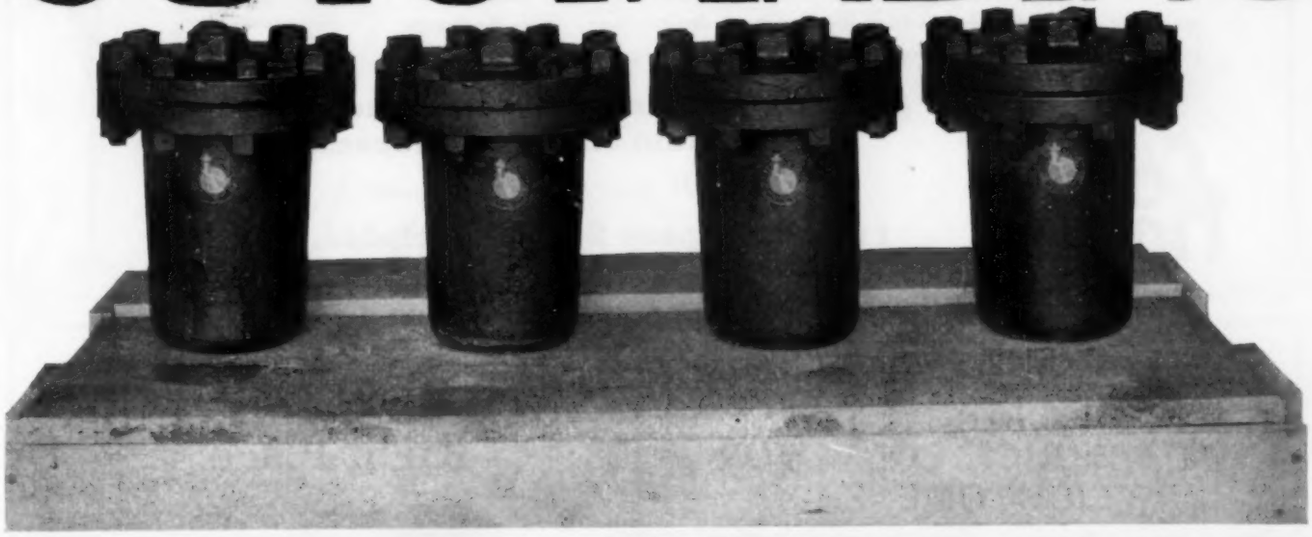
The Sylphon Automatic Radiator Valve is a combination packless valve and temperature control unit. Its motor element is the dependable Sylphon Bellows. It has no electrical or mechanical accessories to get out of order. Easily installed and inexpensive—architects and engineers specify it with full confidence in its lasting efficiency.

It is fully described (both types—angle and globe) in our illustrated printed matter which will be gladly sent. Write today for Bulletin XB 250.

FULTON SYLPHON CO.
KNOXVILLE, TENN., U. S. A.

Representatives in all Principal Cities in U. S. A.,—European Representatives, Crosby Valve and Eng. Co., Ltd., 41-2 Foley St., London, W. I., Eng.; Canadian Representatives, Darling Bros., Ltd., 140 Prince St., Montreal, Que., Canada.

OUTSTANDING



TRAP SERVICE

even on nitric acid

The above photograph shows four Armstrong steel traps shipped for service in a nitric acid plant in Soviet Russia. These traps will handle 65% nitric acid at 100 lbs. pressure.

On high pressure steam service, these forged steel traps give equally outstanding service. They are available in sizes to drain condensate efficiently at steam pressures to 1350 lbs. and any degree superheat.

All Armstrong Traps give practically attentionless service. They cannot airbind; they discharge scum and sludge with the condensate (the swirling upward motion of the discharge makes them self-scrubbing); they are self-contained and can be supported by the connecting pipes; they are small in size, yet have large capacity; heat treated chrome steel valves eliminate wire drawing; they are always water sealed against steam leakage. And they are made and guaranteed by a company that has specialized on traps alone for 19 years.

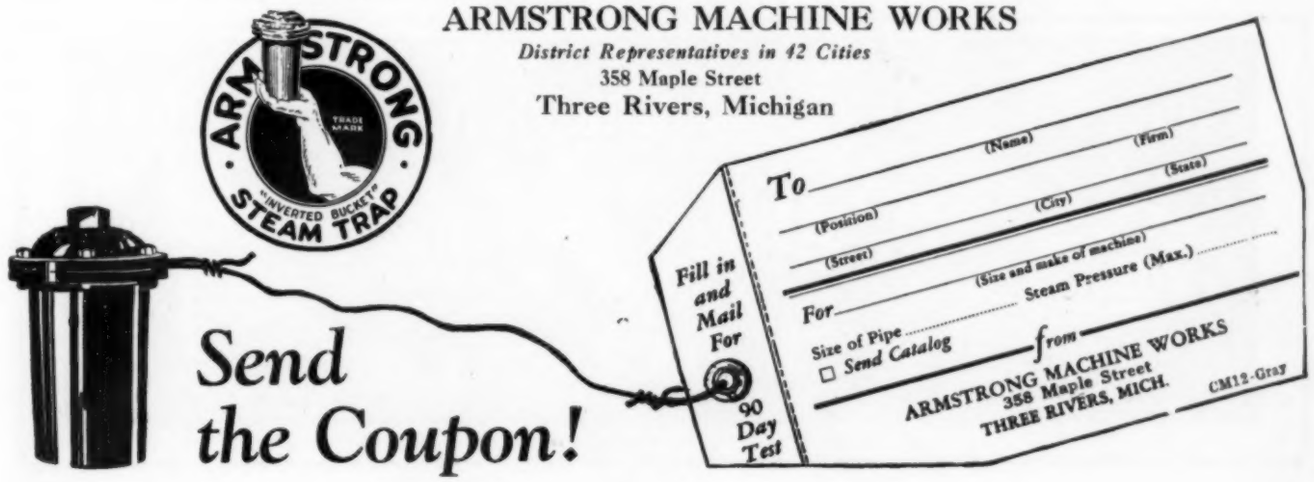
Let us send you as many Armstrongs as desired for 90 days' free trial, without cost to you or obligation. At the end of the period return the traps collect. The coupon below is for your convenience.

ARMSTRONG MACHINE WORKS

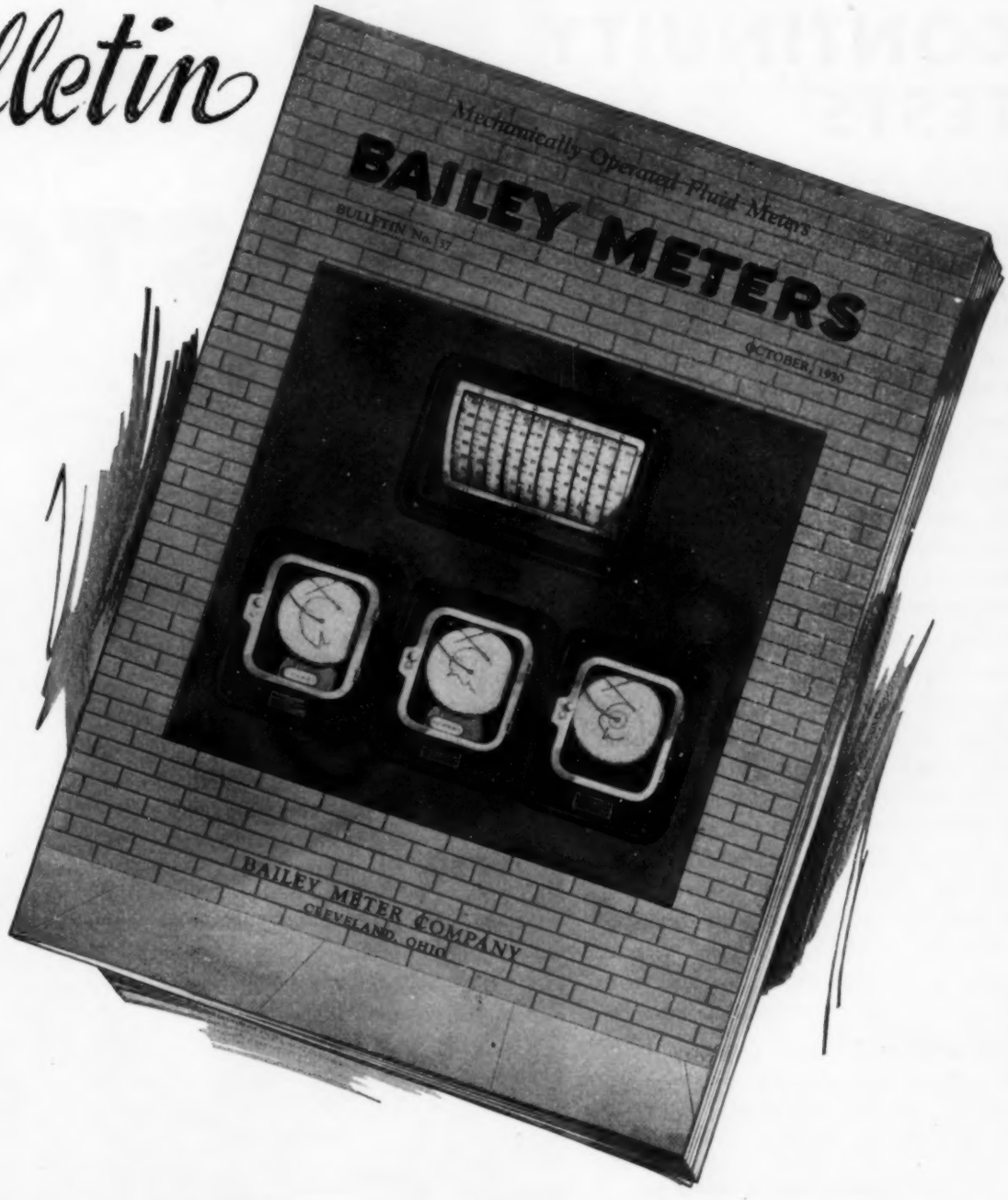
District Representatives in 42 Cities

358 Maple Street

Three Rivers, Michigan



Write for your Copy of this New Fluid Meter Bulletin



BAILEY METER CO.

1054 IVANHOE ROAD CLEVELAND, OHIO.

Bailey Meter Company Limited, Montreal, Quebec

for MEASURING RESISTANCE and MAKING CONTINUITY TESTS

To meet the growing demand for a low price portable ohmmeter for measuring circuit resistances and continuity, Weston now offers the double range Model 563 D. C. Circuit Tester. This new comer to the Weston line is accurate, compact, and rapid in operation. It is handsomely designed, thoroughly dependable, and built to withstand the hard service encountered in field service work.

The two ranges of the instrument 0-50,000 and 0-5000 ohms permit an unusually wide scope of measurements; thus this one instrument serves for practically all resistance testing usually encountered.

Model 563 is a high sensitivity instrument, hence the drain on the self-contained 1.5 volt dry cell is exceedingly slight—on the high range, only 1 milliampere and on the low range, 10 milliamperes. On the high range the life of the cell is therefore practically its "shelf" life and assures long service before necessity of replacement. Write for Circular LL which gives more detailed information about this new instrument and its many uses.

WESTON ELECTRICAL INSTRUMENT CORPORATION
590 Frelinghuysen Avenue, Newark, N. J.

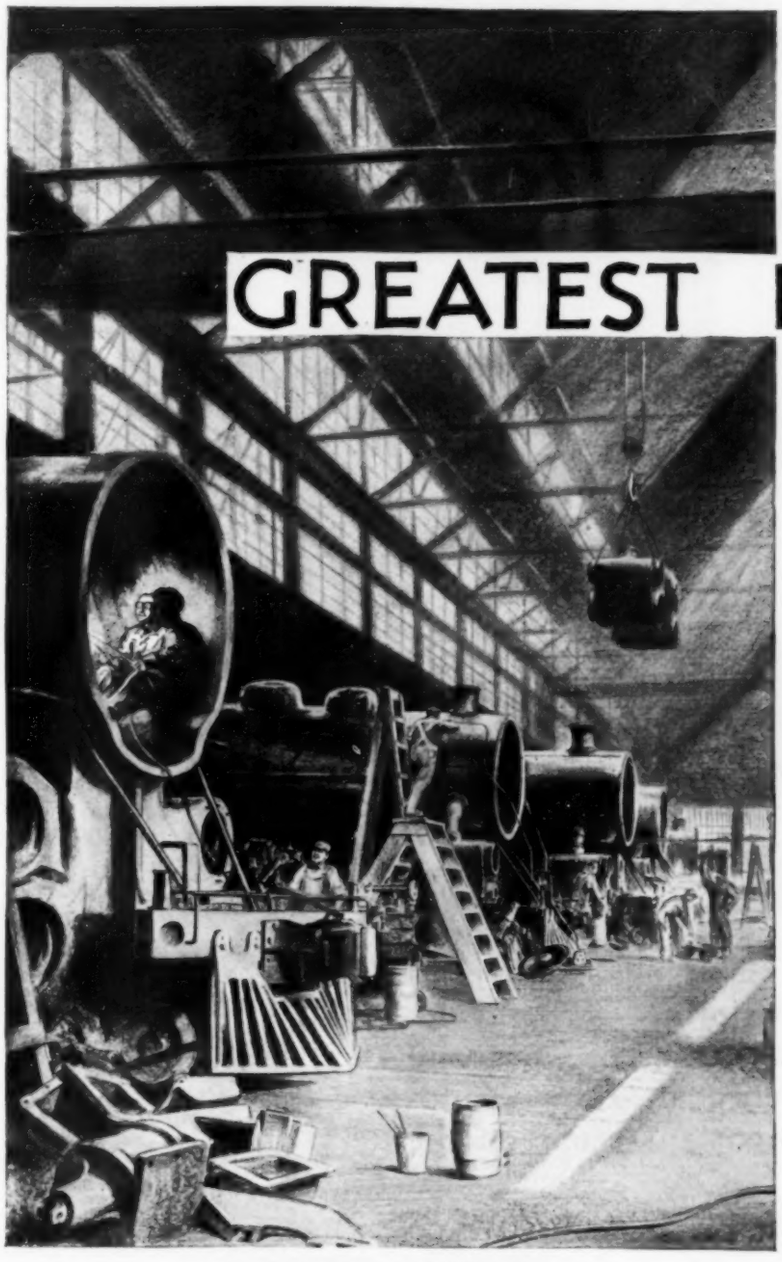
DESCRIPTION OF MODEL 563

Model 563 contains a standard high resistance Model 301 3¼" diameter meter and has two ranges of 5,000 and 50,000 ohms, *two binding posts, a toggle switch for range selection,* and a pair of 30 inch cables. A voltage adjuster on top of the instrument provides an easy means to compensate for any changes in potential of the *self-contained* 1.5 flashlight battery cell. The complete instrument weighs only two pounds.

WESTON

MODEL 563
D. C. Circuit Tester
(Actual Size)

The Recorder—As a result of extensive research in the design of the recorder, this instrument has reached a high state of perfection. A fine, clear line is made on a circular chart which revolves once in twenty-four hours or seven days, as desired. The ten-inch evenly divided chart permits accurate readings at all ranges. This instrument may be had separately or in combination, with the indicator and integrator. It enjoys all the advantages of electrical operation but is absolutely independent of any errors due to voltage or frequency changes. It is designed and built to give years of continuous service under the most adverse conditions.



52 of the GREATEST RAILROADS

...Offer This Suggestion to Operators of Power Plants

YOU buy your fuel on a B.T.U. basis—you run tests to determine which fuel best suits your plant—you weigh every ton of coal or measure every gallon of fuel oil you purchase—you make a fight for any shortage—you keep an accurate record of when and where each purchase is made. Does your interest end there?

Economy in buying does not guarantee economy in use. It's the heat and power you get out of the fuel that counts. Suppose your boilers *are* operated efficiently—what happens to those extra B. T. U.'s you fought so hard for back in the coal pile? How do you know that the rest of your plant does not waste all that your purchasing department and boiler house save?

52 of the greatest railroads in the United States are successfully checking this waste with Republic Flow Meters—the flow meter built for industrial service.

Bulletin "Republic Economy in Industry" mailed upon request.

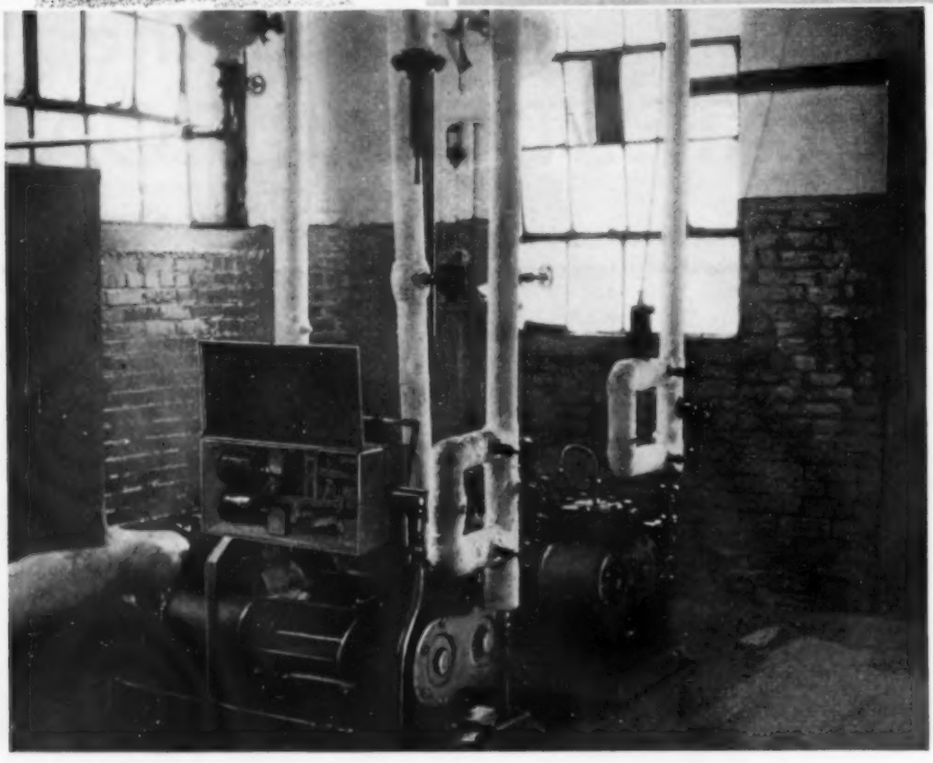
REPUBLIC
INSTRUMENTS

REPUBLIC FLOW METERS COMPANY
Executive Offices and Plant: 2233 Diversey Parkway, Chicago, Illinois
Branch Offices in 25 Principal Cities
Dominion Flow Meters Co., Toronto, Canada Electroflo Meters Co., London, Eng.

REPUBLIC·FLOW·METERS

TURN THE WASTE OF TODAY INTO THE PROFITS OF TOMORROW

In Chemical Plants



Brown Automatic Control on Tar Processing Units.

WHERE the marvels of modern applied chemistry are performed—where silk is made from "sows' ears"—perfumes and colors won from unlovely coal—Brown Automatic Controls are important props on the industrial stage.

Write for Automatic Control Bulletin No. 85-7 and other Brown Automatic Control literature.

THE BROWN INSTRUMENT COMPANY
4478 Wayne Avenue Philadelphia, Pa.
Branches in 20 Principal Cities

Brown Automatic Controls

To Measure is to Economize

Parks-Cramer

Industrial Heating by Oil Circulation

Chapter the Twenty-second

Distribution or Transportation of heat at temperatures as high as 600°F presents problems in piping engineering not met in an ordinary day of industry.

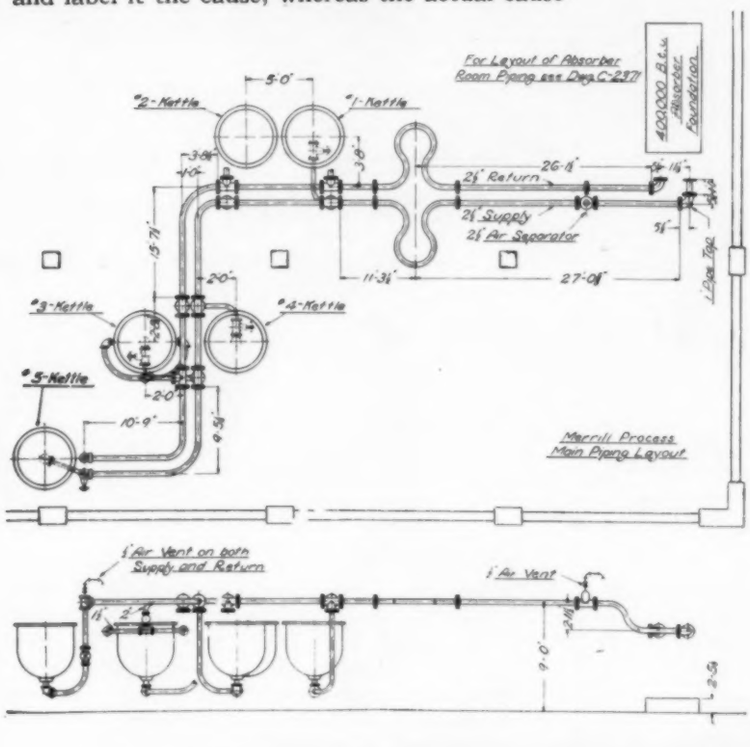
Water at low temperature and pressure needs only a pipe line—steel, brass, or lead.

Steam in common practice uses only standard commercial 125 # materials and screw joints, easily made tight with joint compounds. Even when steam is superheated at high pressure and temperature, there are now plenty of materials available to hold and transport it, although these materials had to be developed when the demand came.

Now, right here I want to talk about Cause and Effect. They are brothers—inseparable twins—and oftentimes one is mistaken for the other. This is particularly true regarding invention—we are apt to view invention as the starting point and label it the cause, whereas the actual cause is a certain demand of which invention is the effect.

When, therefore, it becomes necessary to invent something to satisfy a certain demand, the inventor is oftentimes hampered in his work because of obstacles thrown around him, such as a market not able to supply him with certain much-needed materials.

When the demand came for a circulating heating system that would furnish heat at high temperature—namely 600°F, and at low pressure, the first question raised was what to use for a heating medium. The solution was to find a high boiling point liquid and, naturally, we turned to oil. An oil was finally produced that would answer perfectly, but our quest for material had only begun. The high boiling point oil used in an atmosphere-vented system circulated at a pressure of only a few pounds, but the oil could not be transported in ordinary pipe and fittings, as neither screw nor flanged joints in common use could be made to hold. We, therefore, had a problem equal to the original superheated steam lines, plus this question of joints.



Good engineering, properly proportioned with perseverance, finally produced our present "Distribution System" for hot oil. Extra heavy valves and fittings, welded steel flanges, special gaskets for the larger sizes, and a special compound for the small screw joints—all more costly than 125 # stuff, but vital to a clean, high-grade system.

The cut shows a layout—actually installed. Note the expansion bends—the long turns at corners—the offsets—the flexible kettle branches, etc. Each detail carefully studied to transport the B. T. U. safely to its destination.

Insurance companies approve our installations, engineering and construction.

THE first requisite of a good farm crop is good seed.

And what good seed is to a crop, so is a good heating element to any electric heating process. This is well illustrated by the fact that the discovery of Chromel resistance wire in 1906 virtually created the electric heating industry. It is further supported by the fact that today Chromel is used in practically all electrically heated equipment. For high-temperature jobs, Chromel-A is employed, 80% Ni and 20% Cr. When you buy any electric heating apparatus, you will use good judgment in specifying heating-elements of Chromel-A, which has 24 years of good performance to recommend it.

Chromel also is the basis of the most widely used thermo-couple, known as Chromel-Alumel, for which all the bigger pyrometer jobs are calibrated. These couples can be used up to 2000°F. and above; guaranteed to be accurate within ±15°F.; have no immersion error and do not have to be packed in the tube; and don't have to be calibrated. It will pay you to have all your pyrometers calibrated for Chromel-Alumel couples.

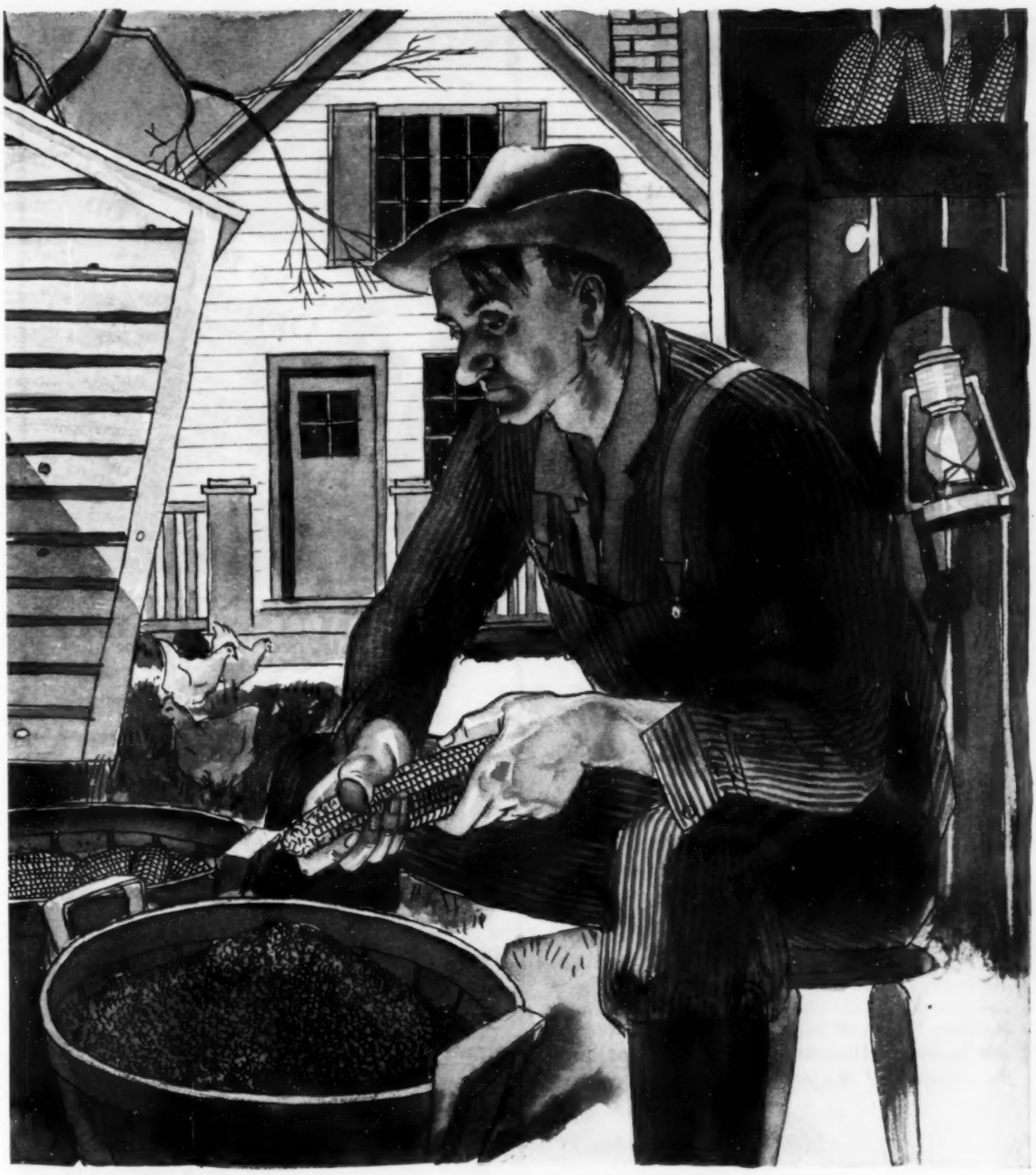
For technical data, send for Catalog G.C. And remember that Chromel couples make your good pyrometers better, and that . . .

—What good seed is to the crop——

Hoskins

is to the Electric

HOSKINS MANUFACTURING COMPANY



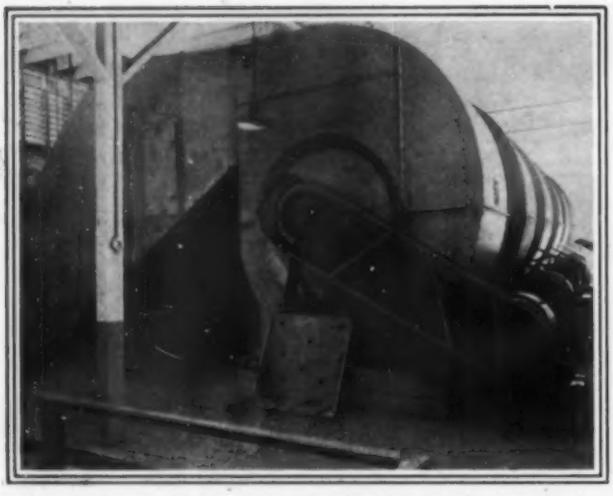
Chromel wire

Heating Industry

4445 LAWTON AVENUE, DETROIT, MICH.

BOSTON, NEW YORK, CLEVELAND, CHICAGO, SAN FRANCISCO

IN CANADA
WALKER METAL PRODUCTS LTD.,
WALKERVILLE, ONT.



Apparatus room at Armour & Co., Glue Works, showing six of the eight fan units used with Sturtevant Dryers. These units replaced other Sturtevant units that had been in operation for over thirty years.

Sturtevant Dryers Accomplish Results

Sturtevant Drying Equipment is accomplishing outstanding results—results that show most favorably on production reports. Drying schedules are shortened, operating costs reduced, high quality of finished product maintained. These savings are factors. that make this equipment the standard for drying all kinds of products in the various industries.

The drying requirements of some products necessitate specially designed equipment to obtain the highest operating efficiency. In cases of this kind Sturtevant engineers determine the design of the equipment through laboratory tests and research. This service assures manufacturers of apparatus that will meet the specific requirements with the utmost economy.

Whatever your drying problems are—new equipment, remodeling old apparatus or extending present facilities—Sturtevant engineers can give you invaluable assistance. Have one of them call and explain the advantages of Sturtevant Drying Equipment.

B. F. STURTEVANT COMPANY
HYDE PARK, BOSTON, MASS.
Sales offices in all principal cities

Sturtevant
(REG·U·S·PAT·OFF·)

Drying Equipment

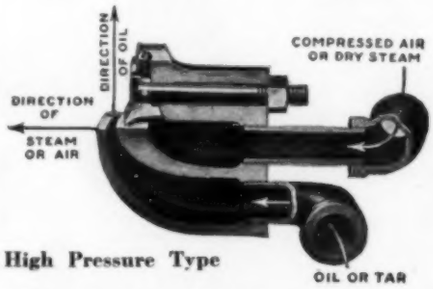
Save Up to 50% on Drying Costs

Astounding results in cutting drying costs have been obtained by Louisville Drying Engineers with many products not previously dried with rotary dryers. Space has been conserved, labor and operating expenses have been reduced, and fuel costs halved, even when a saving in the drying room seemed remote. Engineering knowledge developed from 40 years' specialized drying experience will insure a dryer installation built specifically to your needs and demonstrated as to operation, quality of product, and savings. If you dry any bulk material, ask for details.

We will gladly test your product and submit recommendations. No obligation, of course.

LOUISVILLE
DRYING MACHINERY COMPANY.
Incorporated
451 Baxter Avenue, Louisville, Kentucky
Cable Address—LOUDRY, Louisville, Ky.

For Low Fuel Cost specify W. N. BEST Oil Burners



High Pressure Type

Used in 25 Countries and on Every Continent

When such well-known concerns as General Electric, Ford, New York Central, Bethlehem Steel, etc., use W. N. BEST Oil Burners they must combine efficiency and economy.

There are over 80,000 in use, and every one has been a revelation to its owners in the way of low fuel cost.

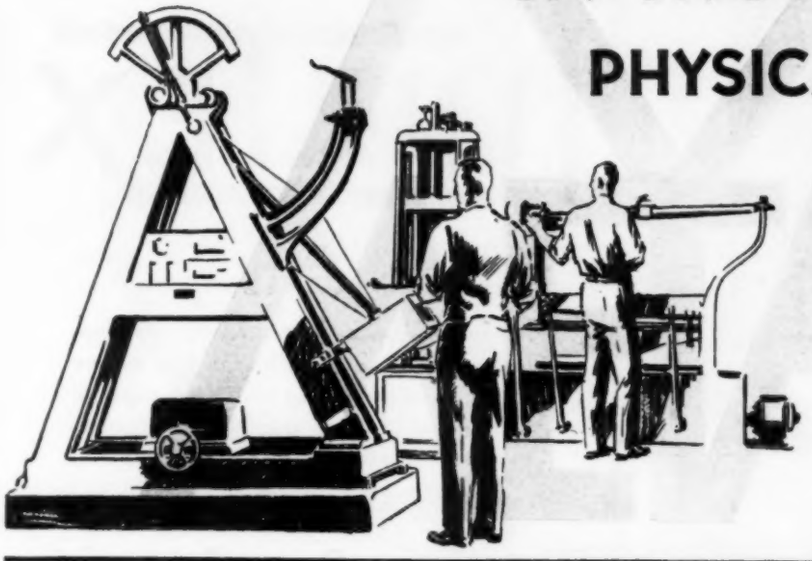
Let our Engineering Service Department show you how to successfully meet every industrial heating requirement.

Write for Catalogs.

W. N. BEST Corporation
295 Fifth Ave. **New York, N. Y.**

ELIMINATE UNCERTAINTY IN IRON CASTINGS

PHYSICAL PROPERTIES OF MEEHANITE GUARANTEED



PHYSICAL PROPERTIES

Castings made under the Meehanite Process are superior to other irons. They have:
Greater Strength and Toughness.
More uniform grain Structure and Hardness.
Greater Resistance to Abrasion.
Greater Density.
Higher Resistance to Corrosion.
Freedom from spongy regions regardless of casting section.
Better Machinability.

Specific properties obtainable on specification:

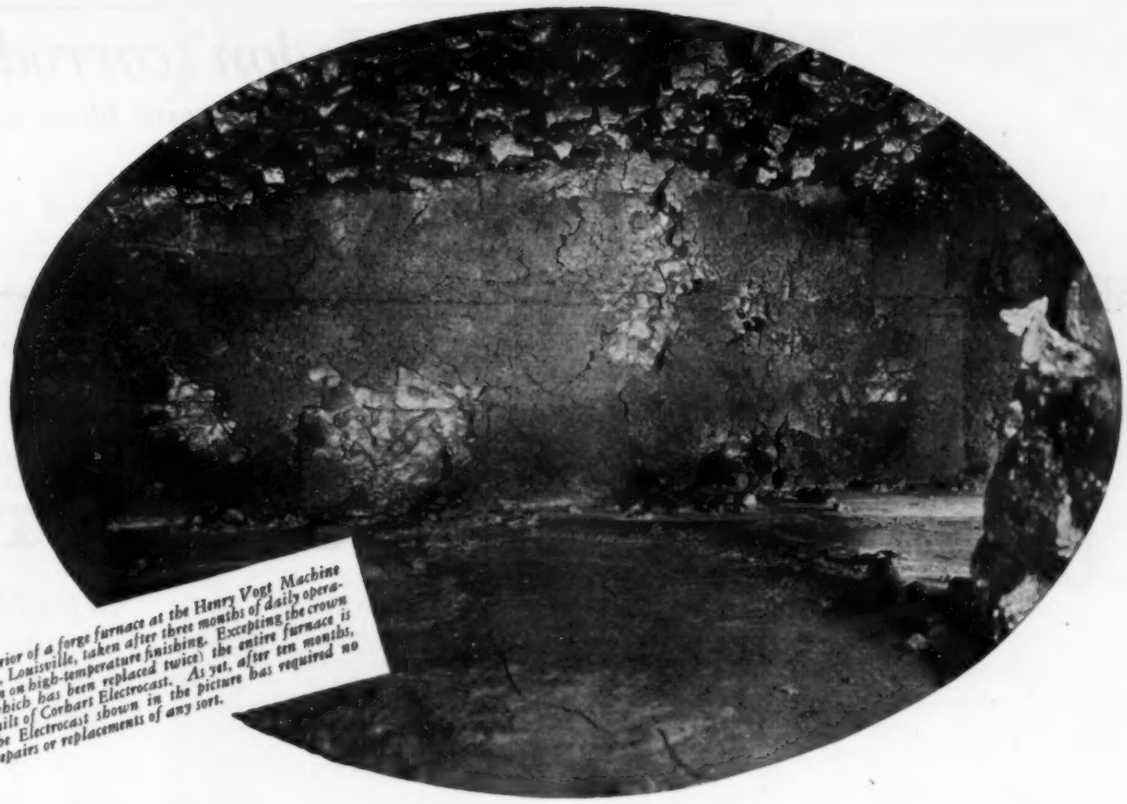
Tensile Strengths to 50000 lbs. without heat treatment.
Tensile Strengths to 70000 lbs. with heat treatment.
Brinell Hardness up to 600 by heat treatment.
Six times the impact strength of semi-steel.

WHEN you use Meehanite castings, you can depend on their pre-determined physical properties as a basis for engineering applications. The strength, density, and grain structure of Meehanite Processed Iron at the heart of a heavy section is as good as that at its surface, which makes the strength per unit of area the same for heavy sections as it is for thin sections. When using Meehanite castings you can depend on getting a homogeneous structure without the usual objections found in gray iron castings, such as hard spots, brittle corners, spongy regions or planes of weakness « « » » The Meehanite Process is the metallurgical achievement that has placed cast iron in the same category of definite strength standards that gives steel one of its chief values as an engineering material « « » » Meehanite castings are sold on the basis of definite physical specifications worked out by the buyer's engineering staff with the cooperation of the producer's engineers. It is then backed up by the producer's positive guarantee. You buy Meehanite Castings on performance . . . not on faith. You proportion your Meehanite castings mathematically, not clairvoyantly « « » » Get specific information on what Meehanite can do for you from the nearest Meehanite foundry.

MEEHANITE FOUNDRIES

Bethayres, Pa.
H. W. Butterworth & Sons
Chattanooga, Tenn.
Ross-Meehan Foundry Co.
Chicago, Ill.
Greenlee Foundry Co.
Cleveland, Ohio
Fulton Fdy. & Mach. Co.
Detroit, Mich.
Michigan Valve & Fdy. Co.
Indianapolis, Ind.
Indianapolis Casting Co.
St. Louis, Mo.
Banner Iron Works
Trenton, N. J.
Trenton Malleable Iron Works
Toronto, Ont.
Jessop Steel Co.

MEEHANITE INSTITUTE



Interior of a forge furnace at the Henry Vogt Machine Co., Louisville, taken after three months of daily operation on high-temperature finishing. Excepting the crown (which has been replaced twice) the entire furnace is built of Corhart Electrocast. As yet, after ten months, the Electrocast shown in the picture has required no repairs or replacements of any sort.

COMPARE *this Newer, Better* REFRACTORY

Ten months ago the Henry Vogt Machine Co. of Louisville installed Corhart Electrocast Refractories in the forge furnace shown above. After three months' experience, they ordered another complete Corhart installation, *and later, the third.*

In these installations, Corhart Electrocast is giving results superior to those experienced with any other refractory they have ever used. And here are the reasons why:

Almost Zero Porosity... Corhart Electrocast has a porosity of less than ½ of 1%.

High Fusion Point... Electrocast has a fusion point of cone 35, without any appreciable softening range below that point. Under standard load tests the deflection is zero.

Resists Corrosion... Because of its unique combination of low porosity and high fusion point, and its insolubility in molten fluxes, Corhart Electrocast is unusually resistant to the corrosive action of slags and glasses.

Harder than Glass... therefore ideal for use in forge furnaces or other equipment in which ordinary refractories usually crack and abrade.

Withstands Great Temperature Changes... Because of its thorough annealing, Electrocast withstands rapid temperature changes much more readily than a body of its density would indicate.

If you are having refractory troubles of any sort, we earnestly suggest that you get the facts about Corhart Electrocast. We may be able to help. If not, we shall quickly say so. Write now for Bulletin 51-C. No obligation—no annoying follow-up. *Address:* Corhart Refractories Co., *Incorporated,* 16th & Lee Sts., Louisville, Kentucky.

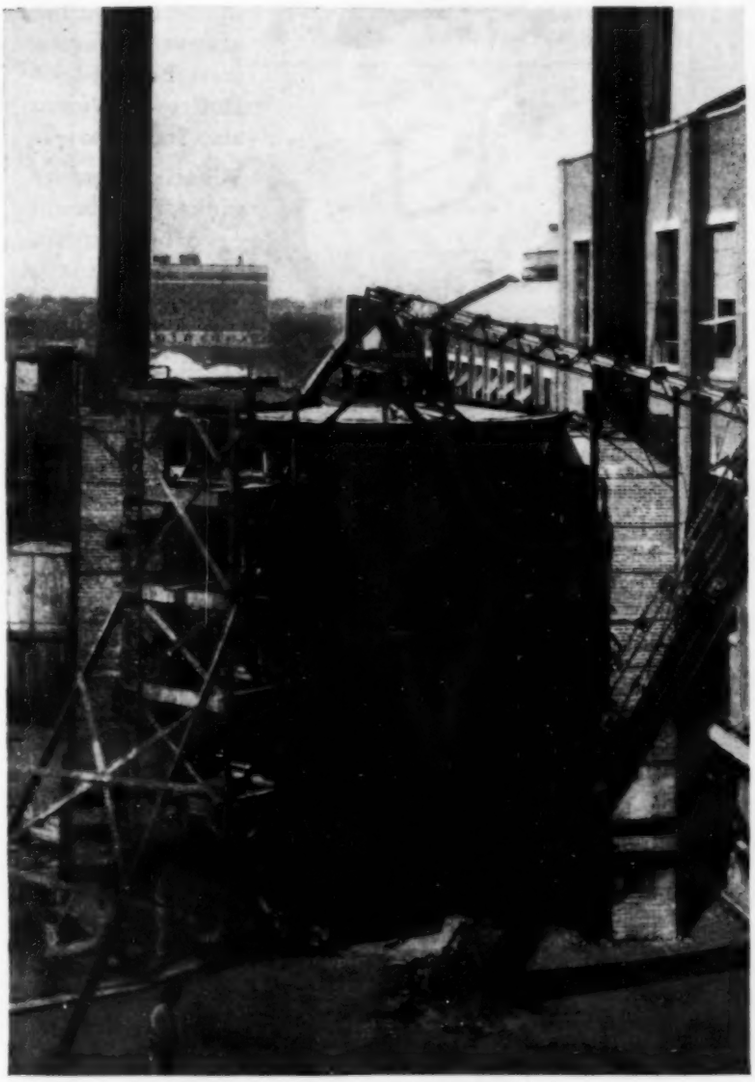
IN EUROPE
L'Electro Refractaire
5 Rue Cambacerès, Paris

QUALITY ECONOMY ENDURANCE

IN JAPAN
Asahi Glass Company
Marunouchi, Tokio

CORHART ELECTROCAST REFRACTORIES

Prolong the life of your filtering materials



After careful comparison of the Wedge Roasting Furnace with other furnaces the user finds that time lost to any cause whatever is at a minimum. Its sturdy construction, its design and correct fundamental principles insure long life. And it is built to meet the purchaser's problem.

More and more sugar and oil refineries are turning to the Wedge Roasting Furnace to revivify and regenerate their filter earth or filter aid. They find it ideal for this work. It is efficient, economical, and it gives many years of satisfactory service. Above all, it greatly prolongs the life of their filtering materials.

That the Wedge Roasting Furnace has distinctive advantages is obvious. The material in process is given just the right amount of treatment for best results. The filter earth or filter aid is kept at a uniform temperature on each succeeding hearth. The material is kept on each hearth for a definite period and at no point of its travel is it subjected to direct contact with ruinous gas or oil flames. The temperature is under direct control of the operator at all times.

Further, the large well-insulated central shaft of the Wedge Roasting Furnace provides quick and easy accessibility to the locking devices and the cooling system of the rabble arms. As a result, rabble arms may be changed in comparatively few minutes—without cooling the furnace. The furnace is sturdily constructed—it can be modified to burn any kind of fuel, and it is designed to meet the purchaser's particular problem. Write for Bulletins F15 and F16, containing complete information on the Wedge Roasting Furnace—your request will receive prompt attention.

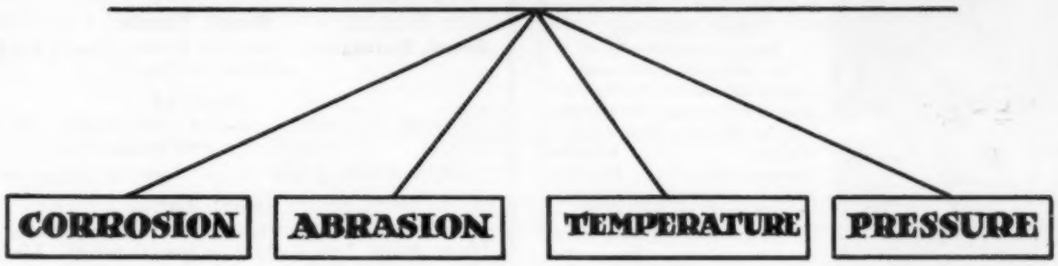
BETHLEHEM FOUNDRY
and MACHINE COMPANY
Bethlehem, Pa.
Wedge Furnace Department

WEDGE
Roasting Furnace

Other Products include: Chemical Equipment of all kinds, Original Frederking Apparatus, Castings of Iron "Tantiron" and Special Irons, Special Machinery, Cement Plant Machinery, "Stellited" Parts, etc.

STAINLESS FORGINGS

—for Resistance to



Oil Refinery and Chemical Plant Equipment Forgings

BALDT'S EXPERIENCE in the successful forging and heat treatment of Ferrous and Non-Ferrous Alloys is at your service.

BALDT is equipped to produce various shapes, whether drop forged, upset, or forged from billets on flat die hammers—Capacity ¼ lb. to 10,000 lbs. "If it can be forged—consult Baldt."

One of Our Specialties:
—Valve Forgings

We are daily supplying some of the country's leading valve makers with Stems,—Seat-Rings, etc., forged of Stainless Steel, Monel Metal, Nitraloy, Nickel or Bronze,—to customers' specifications.

Write for particulars.

BALDT

Anchor, Chain & Forge Corp.
CHESTER PA.

Long, continuous service is assured with Homestead Quarter-Turn valves on the job, for they are cast in brass, iron, steel, acid resisting bronze, monel, or other metals to resist the action of specific fluids at specified temperatures and pressures.

FOR THIRTY-NINE YEARS---

Engineers have recognized the fact that Homestead Quarter-Turn Valves stop costly leaks, give longer, continuous service, and lower maintenance costs.

They have found thru long experience with Homesteads that these savings are made possible by the carefully ground metal to metal seating surfaces, sealed bottom and bonnet, and the quick, positive cam seating action.

It is these features that help to put an end to valve troubles and afford industrial plants the long low-cost valve service that they desire. It is also these features that quickly off-set and justify the higher first cost of Homesteads.

If you, personally, have not yet experienced the satisfaction and savings afforded by Homesteads either by using them in your own plant or by specifying them on you consultation jobs, it will pay you to investigate them at once.

Catalog number thirty-five will help you in writing Homesteads into your next valve specifications. Write for your copy to-day.

You can add Homestead Valves' low maintenance advantage to most any piping layout because they are made in straight-way, three-way and four-way types — sizes up to 12"—for pressures as high as 3000 pounds.

HOMESTEAD VALVE MFG. CO.

P. O. BOX 300 CORAOPOLIS, PENNA.

CAPACITY
FOR MASSIVE CONSTRUCTION

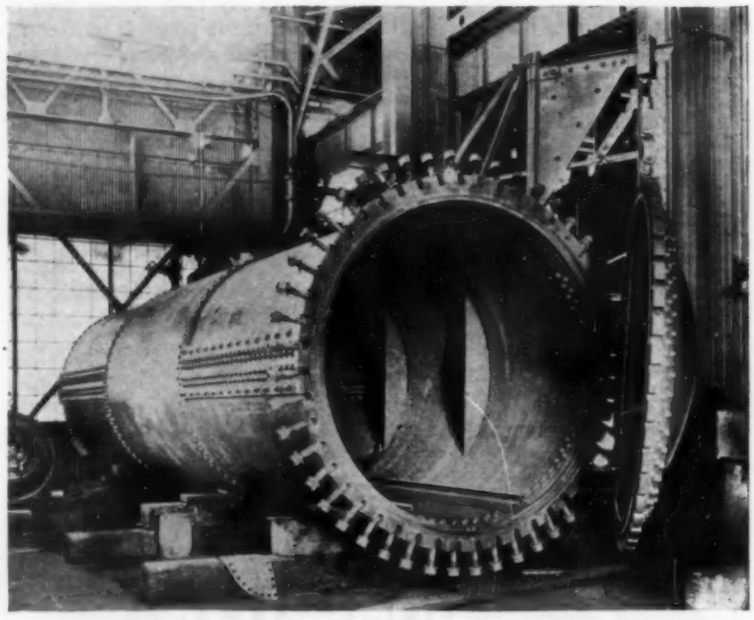
WE ARE EQUIPPED for massive construction and quantity production. Our facilities permit us to build in our shops at one time numerous pieces of equipment of large proportions.

TOWERS
STILLS
CONDENSERS
HEAT EXCHANGERS
TANKS . . .

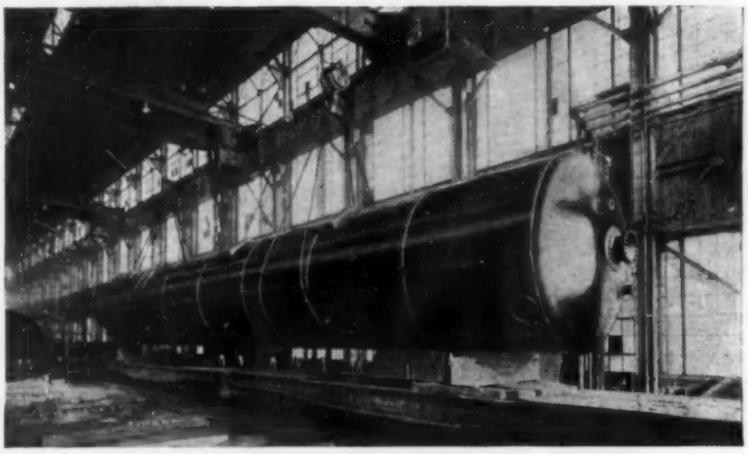
SPECIAL HEAVY BUILT TANKS . . .
RIVETED AND WELDED CONSTRUCTION

STILL BOTTOMS
ANGLE WORK
FABRICATED
PLATE WORK

Rail or Water Shipments
Estimates on Request



IMPREGNATOR SHELL



TOWER—13' 4" DIAMETER x 95' HIGH—WEIGHT 250,000 LBS.
HANDLED AND SHIPPED IN ONE PIECE

SUN SHIPBUILDING & DRY DOCK CO., Chester, Pa.

RESISTS THE ATTACKS OF TERMITES AND OTHER INSECTS

Termites and other insects may be minute in size, but there is nothing small about the extent of the damage they can do to any wood structures that may be exposed to their attack. A number of impregnating materials are in use, that provide a degree of protection, but most of them are not entirely satisfactory.

The use of Halowax as a preservative for certain types of woodwork is suggested for combating the attacks of insects, and it has the added advantage of possessing moisture proofing and fire retarding properties. It is miscible with asphalts and pitches, and various types of rosins and resins.

Halowax possesses an unusual combination of properties, a description of which will be found on the back of this insert. Upon request, we shall be glad to send samples for testing purposes. We also offer, without obligation, the services of our Engineering Department, to aid you in the solution of your problems.

HALOWAX CORPORATION
DIVISION OF BAKELITE CORPORATION
247 Park Avenue - - New York, N. Y.

HALOWAX

PROPERTIES OF HALOWAX WAXES

They range from a crystalline to an amorphous solid.

They range from a translucent neutral color to a dark yellow.

They will not support combustion.

Their specific gravity is from 1.40 to 1.7 at 300 deg. F.

Their melting point 190 to 260 deg. F.

Their boiling point 550 to 700 deg. F.

They are soluble in practically all organic solvent liquids and oils when heated therewith.

They are high in dielectric strength and have an extraordinary specific inductive capacity.

They are insoluble in caustic alkaline solutions and acid solutions except those that are powerful oxidizers.

They are a solvent for many aniline and other dyes; for rubber, gutta percha, varnish gums and resins, for mineral and vegetable oils, and for other waxes when mixed in the molten state.

They are neutral and non-corrosive to metals.

They are free of moisture and will not absorb moisture.

They melt to a liquid of low viscosity.

They have a faint aromatic odor.

PROPERTIES OF HALOWAX OILS

They are thinly fluid mobile liquids.

They leave no deposit when heated.

They are almost colorless.

Their specific gravity ranges from 1.20 to 1.27 at 68 deg. F.

They are liquid down to -25 deg. F.

They congeal at -33 deg. F.

They have a standard flash point of about 350 deg. F.

They are volatile at 212 deg. F. and slightly so at normal temperatures.

Their boiling point ranges from 480 to 550 deg. F.

Their specific heat between 86 and 140 deg. F., is 0.282.

They are insoluble in caustic alkaline solutions and acid solutions except those that are powerful oxidizers.

They are soluble in practically all organic solvent liquids and oils; the best are carbon-tetra-chloride and benzol. They are also a solvent for many aniline and other dyes, for rubber, gutta percha, mineral and vegetable oils, varnish gums and resins and for other waxes when mixed in the molten state.

They are free of moisture and will not absorb moisture.

They are neutral and non-corrosive to metals.

They are high in dielectric strength and have a characteristic odor, not, however, unpleasant, heavy or persistent.

HALOWAX CORPORATION
DIVISION OF BAKELITE CORPORATION
247 Park Avenue - - New York, N. Y.

HALOWAX

TIME—THAT TOUGH OLD TESTER

Here is Time, that Tough Old Tester of everything in this world. To his aid, Time calls all the destructive forces of the universe. Years come and go, storms and sunshine, heat and cold make their accustomed rounds, while Time, the Tough Old Tester, broods over the world, trying, testing, destroying.

Yet Time, the Tough Old Tester, does have his troubles. Against one material devised by man, Time and his servingmen falter. The material is genuine Puddled Wrought Iron—the metal of which Reading 5-Point Pipe is made.

READING IRON COMPANY, Reading, Pennsylvania

Use only Reading 5-Point Nipples with Reading 5-Point Pipe—you'll know them by the indented spiral band

For Your Protection, This Indented Spiral Forever Marks All

GENUINE PUDDLED WROUGHT IRON
READING PIPE
DIAMETERS RANGING FROM ⅛ TO 24 INCHES

Science and Invention Have Never Found a Satisfactory Substitute for Genuine Puddled Wrought Iron

FIGURE
106-A

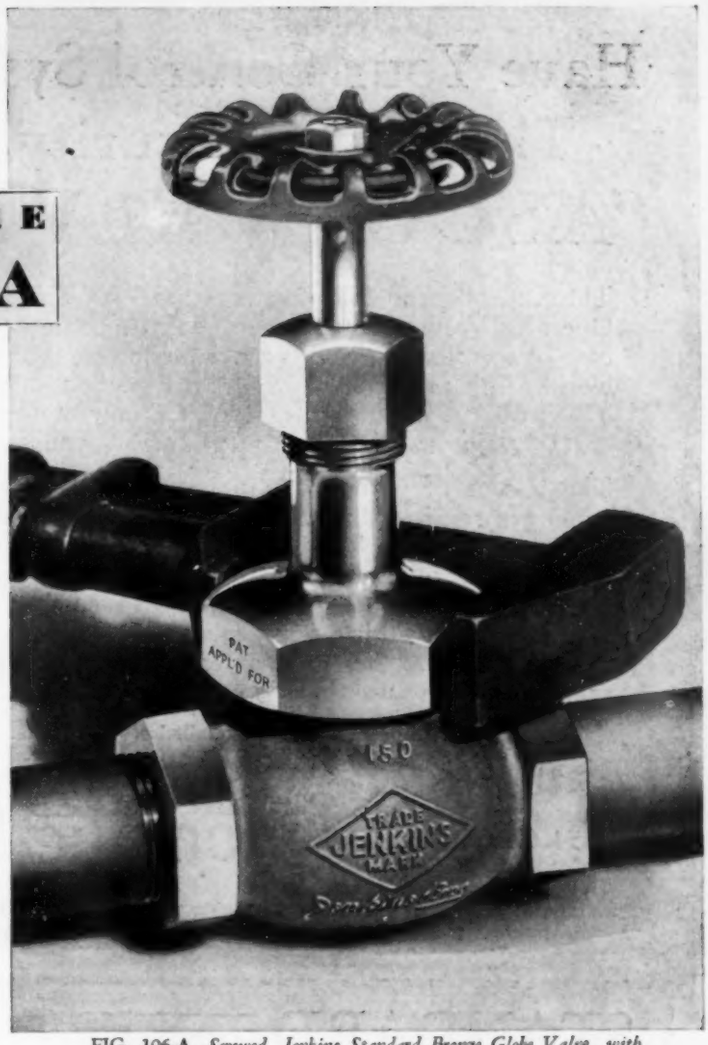


FIG. 106-A, *Screwed, Jenkins Standard Bronze Globe Valve, with one-piece screw-over bonnet and slip-on stay-on disc holder. For 150 lbs. steam working pressure, or 250 lbs. oil, water, gas working pressure.*

This one-piece screw-over bonnet won't distort . . .

Here is a valve that doesn't "fear" a wrench. It is a Fig. 106-A Jenkins Standard Bronze Globe with the one-piece screw-over bonnet.

This bonnet construction provides unusual strength to resist the strains of frequent removal. You can take the bonnet off and replace it repeatedly, and it won't distort. The large hex faces enable you to get a full purchase with a wrench.

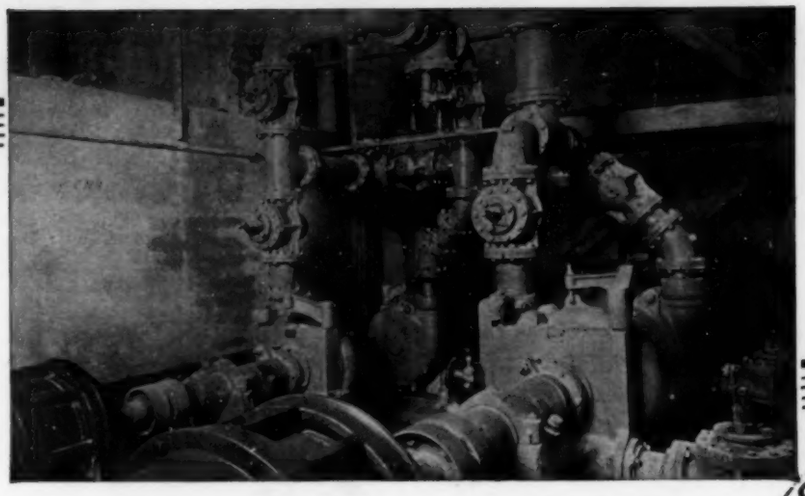
Another advantage of Fig. 106-A is the slip-on stay-on disc holder . . . . a real innovation, possible only in this screw-over bonnet design. Ask your supply man to show you this Jenkins. Its superiority of construction and finish can be seen at a glance. It is made also in angle, cross and check types, screwed or flanged. Write for Bulletin 141 containing details.

JENKINS BROS.

80 White Street, New York, N. Y. 524 Atlantic Avenue, Boston, Mass. 133 No. Seventh Street, Philadelphia, Pa.
646 Wash. Blvd., Chicago, Ill. 1121 No. San Jacinto, Houston, Tex.
JENKINS BROS., Limited, Montreal, Canada; London, England
Factories: Bridgeport, Conn.; Elizabeth, N. J.; Montreal, Canada

Jenkins
VALVES
Since 1864

JENKINS VALVES ARE ALWAYS MARKED WITH THE "DIAMOND"



CENTRIFUGAL WILFLEY PUMPS

Good Tips on a Sludge Pump

. . . *from Cement Plant Operators*

WHAT is it about the Wilfley Slurry Pump that leads one prominent cement manufacturer to write?:

> "We have used Wilfley pumps for years and have always considered them leaders in the field where cement slurry is to be handled."

And another:

> "It is a pleasure to say that these pumps have given us very satisfactory results. The original appeal to us was because they have no stuffing boxes. . . ."

And still another:

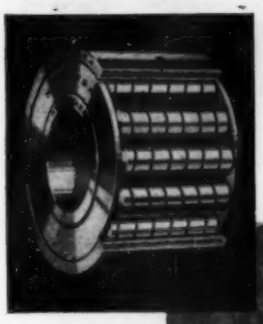
> "In regard to the absence of the stuffing box, we find this to be a great asset in operation. The way the pump is arranged, it facilitates the renewal of parts much more easily than any other pump we have used, and its continuance of performance is far ahead of anything we have used for the conveying of slurry."

These are some of the reasons back of such letters.

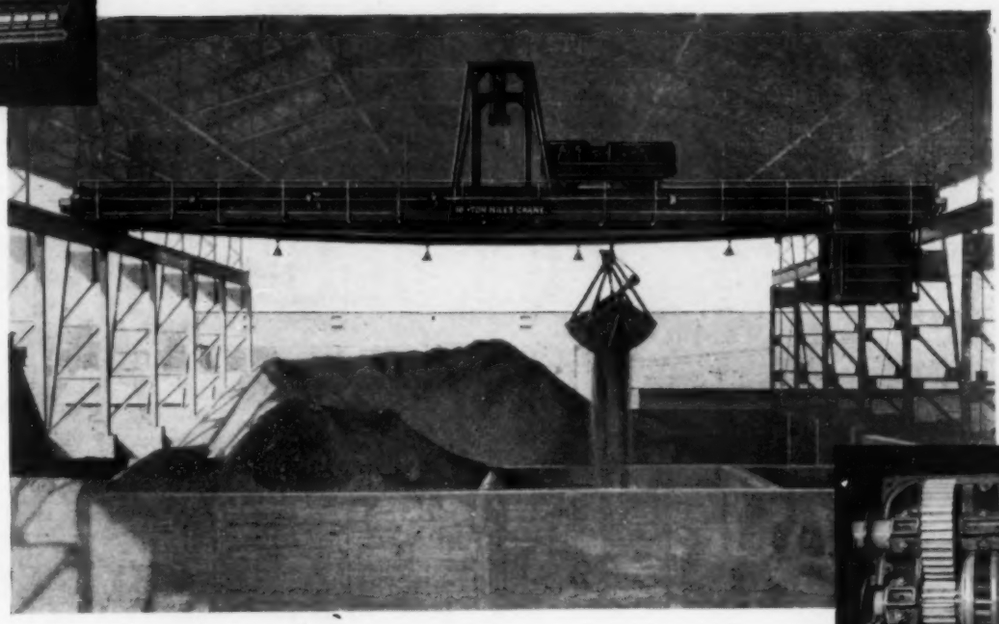
If you were handling cement slurry in your plants, you would be sold on the Wilfley Pump. But why hesitate? There's little difference, if any, between cement slurry and many of the process sludges.

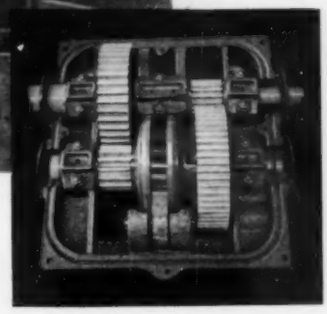
A. R. WILFLEY
& SONS, Inc.
P. O. Box 2330
DENVER, COLO., U. S. A.

WILFLEY Centrifugal SAND PUMP
PATENTED



COMPACT STRENGTH on Roller Bearings





provides stamina in Niles Cranes

HIGH speed reduction gears, load-brake and bearings are compacted into a unit housing in the Niles Crane Trolley. Alignment is lasting—support rigid. And lubrication for all moving parts is positive and continuous from an oil bath within the housing.

Added protection, to insure low cost load handling is provided by roller bearings which practically banish friction. Wear, too, is minimized and maintenance reduced to a minimum.

Throughout every Niles Crane —in traveling, gantry and wall cranes alike—there's strength in abundance to resist the inevitable overloads, and severe service imposed by modern industrial practice. Assure economical handling, not merely for today, but for years to come, with Niles compact reduction-gear and load-brake cranes. They are built up to 450 tons capacity.

SHEPARD NILES CRANE & HOIST CORPORATION

Main Office: 382 Schuyler Ave., Montour Falls, N. Y.

Works: Montour Falls, N. Y., and Phila., Pa. *Branches in Principal cities*

NILES CRANE DIVISION

THE MOST COMPLETE LINE OF CRANES & HOISTS IN AMERICA

HERE'S the latest data!

To help clarify and crystalize the function of air conditioning . . . as applied either to increase human comfort, or to facilitate a manufacturing process . . . is the intent of this bulletin.

Theoretical problems are presented and solved. Calculations of the many factors to be considered, in design and installation, are given in detail. Tables and charts, essential to an accurate determination, are included in Carbondale's Air Conditioning Bulletin.

You will find this literature of considerable interest and assistance. As many copies as needed are yours for the asking. Sign and mail the coupon!

Carbondale Refrigeration

ABSORPTION AND COMPRESSION AMMONIA CARMACO SYSTEMS AND CO2 COMPRESSION SYSTEMS

THE CARBONDALE MACHINE COMPANY
CARBONDALE, PA.

Please send.....copies of the Carbondale Air Conditioning Bulletin

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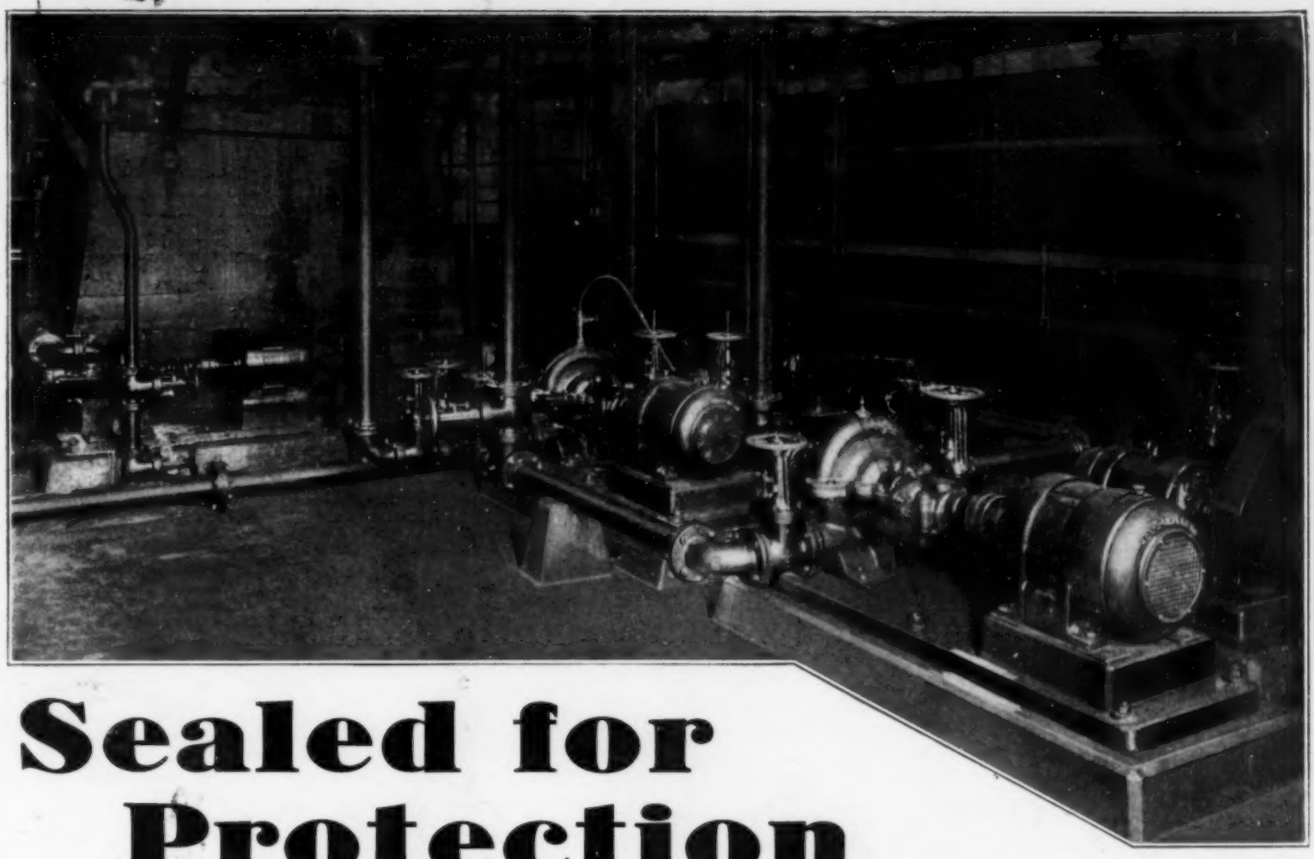
Address _____

City _____ State _____

Dept. C.M.E.



Sealed for Protection

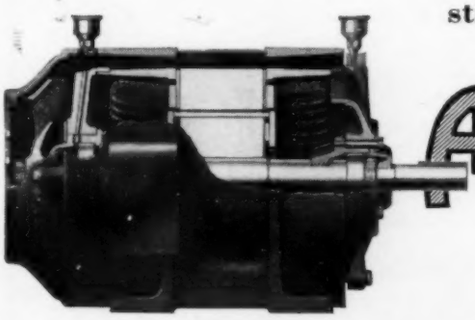
against corrosive gases and liquids

One 5 h.p. and two 15 h.p. (1730 r.p.m.) Type ARZ Motors operating Allis-Chalmers centrifugal pumps, handling brine in an Electro-Chemical plant.

Corrosive moisture and gases, often present in chemical plants, cannot harm Allis-Chalmers totally enclosed fan-cooled motors because the windings of these motors are thoroughly sealed from contact with the outside air.

Because of this protection against harmful corrosives, dust and dirt, the motors may be installed in out-of-the-way places with very little attention except periodic greasing—thus eliminating frequent and expensive inspection, cleaning and repairs.

And this protection is accomplished by a simplified design that includes no rubbing or revolving seals and that provides accessibility equal to that of the standard open type motor.



ALLIS-CHALMERS

Totally Enclosed Fan-cooled MOTORS

Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin

Yes!

MONARCH BUILDS 'EM!

A mixing unit to handle colloidal powders must be perfectly dust-tight as well as an efficient mixing mechanism.

The Mixer shown above is a good example of this type of equipment . . . as built by Monarch. It was made for Morningstar-Nichol, Inc., Hawthorne, N. J., for mixing very fine powders. Has motor and V-belt drive, special stuffing boxes to keep lubricants out and powders in the case and other special features. Capacity is 5000 lbs.

Monarch builds a big line of standard equipment. Monarch is prepared also to build to meet specific requirements, to design and to work with your engineers. Consultation will obligate you in no manner. Write us.

MONARCH PRODUCTS

Roller Mills
Reels
Burr Mills
Attrition Mills
Crushers
Cutters
Packers
Mixers
Percentage Feeders
Material Handling Equipment
Power Transmission

SPROUT, WALDRON AND COMPANY, INC.
20 Waldron Street, Muncy, Penna.

IT'S A . . . MONARCH

The fascinating story of a new force in INDUSTRY

—Send for your copy

Silica Gel is more than a material; more than a process. It is the means of making available to industry the long-latent force of *Capillary Attraction.*

Even those familiar with some of the usages of Silica Gel are amazed as they read of the far flung industrial fields in which Silica Gel processes have proven short cuts to lower costs or a finer product. Interesting accomplishments are listed in the fields of Dehydration, Air Conditioning, Refrigeration, Refining, Solvent Recovery and Catalysis.

A request on your business stationery will bring you your copy of "The Story of Silica Gel".

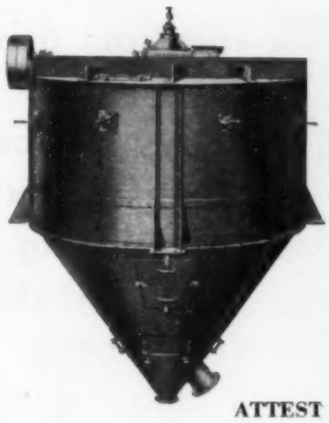
THE SILICA GEL CORPORATION

BALTIMORE TRUST BUILDING BALTIMORE, MARYLAND

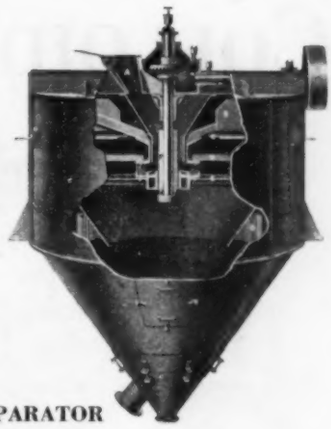
STURTEVANT AIR SEPARATORS

For Producing Products as Fine as 325 Mesh or as Coarse as 50 Mesh—Large or Small Capacities

"EARNED POPULARITY through PERFORMANCE"



Do you know what Air Separators are doing in your industry?



395 ACTUAL INSTALLATIONS

ATTEST THE *POPULARITY* OF THE *STURTEVANT* SEPARATOR

Abrasives, Aluminum
Aluminum Foil (to remove paper)
Barium 99.5% through 200 mesh
Barytes 99.5% " 325 "
Bauxite 95% " 100 "
Boric Acid, Bone Ash
Calcite, Calcium Sulphite
Carbon, Bone Black
Cement (106 installations)
Charcoal 90% through 200 mesh
Clays 40 mesh to 99.9% " 300 "
Coal, Coke, Copper Ore
Chrome, Ore, Dolomite
Diatomaceous Earth
Emery, Facings, Glass
Feldspar 99% through 325 mesh
Fullers Earth 96% " 200 "
Gypsum 90% 100 to 99% 200 "
Hydrate 99.4% through 350 "
Iron Oxide 99.72% " 200 "
Kieselguhr, Lime, Lignite
Limestone 92% through 200 mesh
Magnesite, Manganese
Marble Dust
Ores—Chrome, Iron Oxide
Oxides—Zinc, Iron
Oyster Shell Dust
Phenolphthalein
Phonograph Record Materials
Phosphate Rock
Pyrites, Pyrolusite
Sand, Sawdust
Shale 99.6% through 200 mesh
Silica 97% " 325 "
Slate, Slag, Soap Powder
Soda Ash, Sulphur
Talc, Tobacco Tripoli
Zinc Oxide 97% through 325 mesh

For those not fully acquainted with the modern method of obtaining products finer than 50 mesh, a method that is free of much of the difficulties encountered with screens, we will send the manuals illustrated.

This modern method is termed Air Separation. With it hundreds of firms are simplifying their screening problems amazingly; are largely eliminating costly repairs and upkeep; are substantially cutting labor costs; and are producing with increased capacities a far more dependable product than heretofore, and this at practically any fineness within reason.

Mechanical perfection, uniformity of products, large capacities, and continuous production are some of the reasons why 31 Cement Companies are using 84 "Sturtevants."

They are equally popular in the Lime, Gypsum, Feldspar, Clay, Limestone, Silica, Abrasive, Facing, Barytes, Sawdust, Fertilizer, etc., fields.

If you have a separation problem and you want a dependable, unchanging fine product with a probable increase of capacity from your pulverizers, why not give us such data as you can regarding your material, the fineness wanted, the capacity wanted, etc., etc. Our suggestions should be of value.

STURTEVANT MILL CO. HARRISON SQUARE BOSTON, MASS.

THIS COUPON makes it easy for you to tell us about the wire cloth items in which you are interested,

—and—

This is the catalog that every chemist should keep handy.

This is NOT a bulky space-consuming catalog. It is only 6″ by 9½″ by ⅛″ thick. Yet it contains all the information any chemist needs on wire cloth. It tells how to select, order, and test wire cloth and why it pays to buy the *highest grade*. It tells in detail how to be certain that you are getting the highest grade.

Quality wire cloth has been our specialty for more than 50 years. We are now making the world's finest—400 mesh—160,000 square openings per square inch. Our wire cloth is made of all malleable metals for every chemical purpose, of monel metal, aluminum, brass, copper, bronze, phosphor bronze, nickel, steel, manganese steel, stainless steel, silver, gold, platinum, nickel chromium, tinned metals and special alloys. All meshes. All weaves. All lengths. All widths. We carry an exceptionally large stock which enables us to deliver promptly.

Newark Wire Cloth Company

350-364 Verona Ave., Newark, N. J.

Branch Office: 66 Hamilton St., Cambridge, Mass.

Fill in, Tear off, and Mail this Coupon

Newark Wire Cloth Co.
350-364 Verona Ave.,
Newark, N. J.

Without obligating us in any way please send a copy of your Catalog No. 26. We are interested in the following:

- ☐ The "Newark" Cornerless Testing Sieve;
- ☐ The finest wire cloth in the world — 400 mesh — 160,000 square openings per sq. in.;
- ☐ "Newark" Metallic Filter Cloth;
- ☐ Gasketed Metallic Filter Cloth;
- ☐ Double Crimped Heavy Steel Wire Screen;
- ☐ Steel Wire Cloth;
- ☐ Bran Duster Wire Cloth;
- ☐ Tinned Milled Screen Cloth;
- ☐ Brass, Copper and Bronze Cloth;
- ☐ Market Grade Brass and Copper Wire Cloth;
- ☐ Extra Fine Phosphor Bronze Wire Cloth;
- ☐ Foundry Riddles;
- ☐ Dipping Baskets;
- ☐ Renewable Bottom Strainers.

Name.....

Firm.....

Street.....

City and State.....

A New Book on Mixing

Turbo-Mixers are adapted to all mixing operations. The action of the Simplex and Triplex Types is illustrated herewith. A Turbo-Mixing Unit, consisting of a Duplex Impeller and Curved Deflecting Blade Ring, is shown below.

THE new book on Turbo-Equipment is designed to present for the first time in print, the newest ideas on processes such as mixing, agitation, heat transfer, gas absorption.

The ideas discussed have been thoroughly tested in the laboratory and in many of America's best known plants.

Every engineer and executive will find this book at least thought stimulating, probably of direct value, possibly the key to major economies.

A copy will be sent gladly and promptly on request.

TURBO-MIXER CORPORATION

TRADE MARK

ROOM 804, 250 EAST 43RD STREET, NEW YORK, N. Y.
FACTORY AT HUDSON, N. Y.

4925

TANKS with constant-temperature controls

—*built any size or form desired . . .*

WHERE temperature variations are troublesome in any chemical or physical process carried on in a tank or bath—use a Freas tank with constant-temperature controls—you will thus entirely eliminate this perverse variable; improve the uniformity of your product; and save considerable time and expense.

Freas tanks are especially designed to hold a liquid, usually water or oil, which is electrically heated, and its temperature automatically held constant, at any selected value, by a very accurate thermostatic control.

They are made practically any size or shape desired; operating with various degrees of precision, as requirements dictate, from 0.5° C to 0.002° C; with temperature ranges from below room heat to 100° C and above. For example, the tank illustrated was expressly built 82″ long 33″ wide 17″ working depth, with an operating temperature range from 90 to 115° F, and an accuracy of control within 1° F.

These constant-temperature tanks are thoroughly dependable, and perform their service function satisfactorily regardless of room temperature fluctuations or lack of supervisory attention—holding a definite, constant temperature, accurately, for any period of time.

If you have a problem requiring equipment of this character—write us for a quotation on your specifications, or for recommendations based on our experience with problems of a similar nature.

FREAS

ELECTRIC HEAT AUTOMATICALLY CONTROLLED

FREAS THERMO-ELECTRIC COMPANY

Baking Ovens
Drying Ovens
Vacuum Ovens
Aging Ovens
Conditioning Ovens
Revolving Shelf Ovens

Designing Engineers & Manufacturers

1209 SOUTH GROVE STREET
IRVINGTON, N. J.

Incubators
Sterilizers
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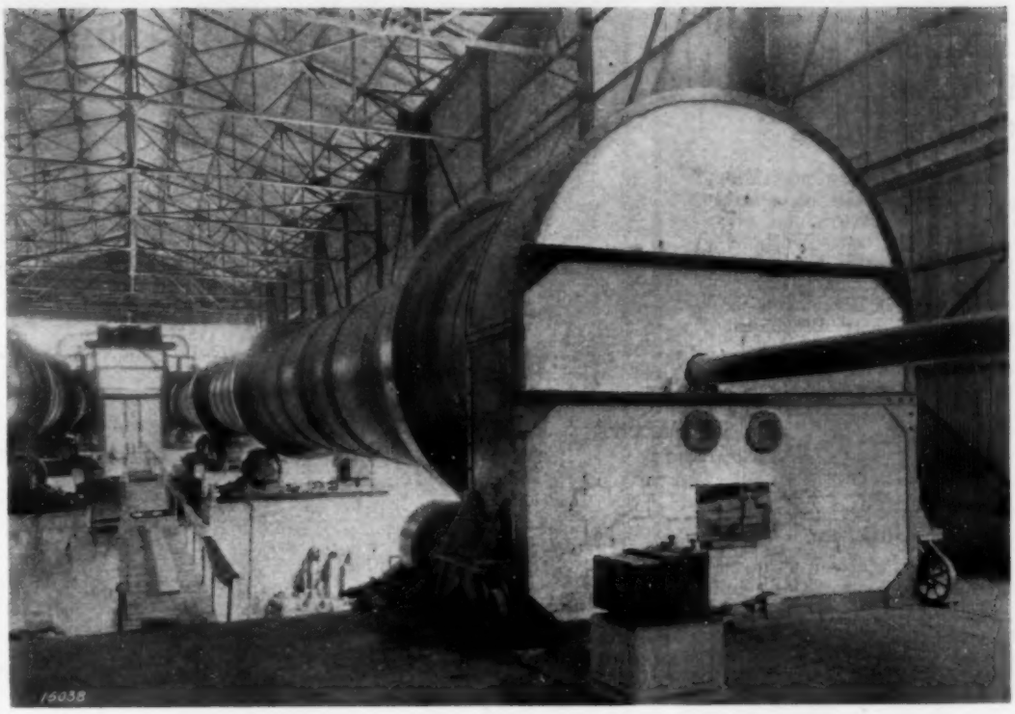
Liquid Air Plants
Temperature Controls



Newest design of kiln for Portland Cement

IS IT LIME? OR CEMENT?

VULCAN has been building machinery and equipment for the cement and lime industry for more than half a century. Some of the first rotary kilns used in this country for the production of Portland cement were products of the Vulcan plant.

Vulcan has kept pace with developments in this industry—has in fact helped set the pace. Vulcan experience and skill and knowledge are available, to help with the development and design of equipment for your purposes—to supply standard machinery for usual processing operations and to build special equipment for unusual requirements.

There's a new Vulcan Kiln Catalog.

Have you had your copy?

VULCAN IRON WORKS
WILKES-BARRE, PA.

VULCAN *of* *WILKES-BARRE*
KILNS

VULCAN PRODUCTS

- Hoists, Electric and Steam
- Locomotives. Steam, Gasoline, Electric
- Rotary Kilns, Dryers, Coolers and Roasters
- Mine Ventilating Fans
- Cages and Skips
- Sheave Wheels
- Coal Crushers
- Gray Iron Castings
- Open Hearth Steel Castings
- Gears, Moulded and Cut Teeth
- Special Machinery

To engineers

AND . . .

. . . maintenance men

The set of Master Specifications herewith is the result of an effort to bring to you concise and reliable information on the subject of iron and steel paint protection.

Its object also is to further advance the recognized claims of merit for flake silica-graphite paints in the submission of pertinent facts gathered in the century old career of the Joseph Dixon Crucible Company.

It is designed to simplify the problem of paint selection and to assist the engineer and maintenance man in a dependable way.

We confidently feel your filing cabinet will welcome it as a "member in good standing."

Ask for Master Specification No. 243-BI.

Paint Sales Division

JOSEPH DIXON CRUCIBLE COMPANY

Jersey City D X N TRADE MARK **New Jersey**

Established 1827

P.S. ***Requests for the Master Specifications will be met promptly. If two copies are required please so stipulate.***

PULMONARY AILMENTS

in all branches of industry
can be better controlled by the use of

WILLSON BAG RESPIRATOR—Type B

In this day and age it is not necessary for the workman at any trade, because of lack of suitable protective equipment, to perform certain operations at the risk of life or health. As improved methods of production cause new or increased hazards, protective devices to suit specific needs are immediately devised and made available.

There are many operations necessarily in atmospheres of dry dust such as in the mixing rooms of ceramic plants, where control of dusty material in bulk is not possible. For these conditions adequate protection is found in the Willson Bag Respirator. Outstanding among its advantages are higher resistance to dust; greater breathing area and genuine comfort to the wearer.

No part touches the face except the soft bag filter which completely encloses the anatomically-shaped rubber form . . . full freedom of vision is allowed and eye glasses or safety goggles can be worn . . . there is no interference with speech and the large area of breathing space permits free, easy breathing. . . . . All parts are replaceable without tools; the bag filter is washable and can be used many times.

Price with one extra filter, $2.00, f.o.b. Additional filters packed three to a box $1.00 per box f.o.b. shipping point.

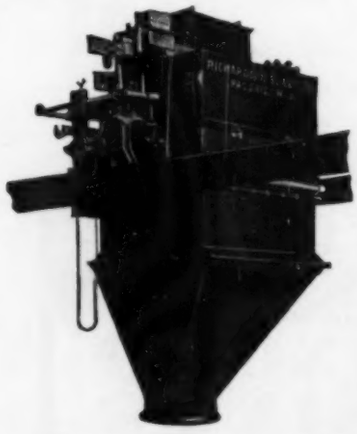
WILLSON PRODUCTS Inc.
READING, PENNSYLVANIA

The RICHARDSON Sacking Scale

for dusty, granular and powdered materials

No longer is it necessary for a man to eat the material he is sacking because of the dust in the atmosphere. The Richardson Enclosed Type Sacking Scale confines the dust, within the scale and makes for a clean-working installation.

All operating levers are arranged on the outside of the dustproof casing and are therefore free from dust and easily reached for examination, replacement or adjustment when necessary. This freedom from dust prevents clogging and sticking of parts and insures longer life of the entire machine.



Suitable for weighing all granular and powdered materials such as soda ash, cement, fertilizers, fuller's earth, borax, castor pomace, clays, nitrates, potash, sulphur, feeds, meals, butt dust, flake graphite, tankage, etc., etc.

ADVANTAGES:

Saving of time—A Richardson Sacking Scale operates at from 2 to 6 or more sacks per minute, depending on the nature of material being handled and the quantity being weighed.

Saving of Labor—With the Richardson Sacking Scale one man can sack as much material as 2 or 3 men can with ordinary hand weighing system. In one plant, as many as 4 men were eliminated by the installation of one Richardson Sacking Scale.

Increased Profits—Because of the minimum amount of time and labor needed, the Richardson Sacking Scale earns its cost the first year, and this means added profits in its continued operation.

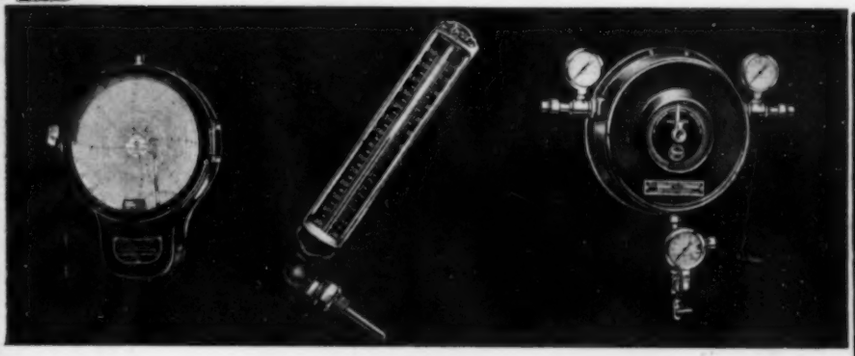
Satisfied Customers—The accuracy of the Richardson Sacking Scale is guaranteed to be within ¼ of 1% and you do not shortweight your customers. Neither do you give away material, thus saving additional money to be added to profits.

Invest in a Richardson now. An automatic sacking scale is not a luxury but a downright necessity if you are looking forward to reduced costs and increased profits.

Richardson Scale Company
Clifton, New Jersey

NEW YORK BOSTON PHILADELPHIA PITTSBURGH
CHICAGO ATLANTA GULFPORT MINNEAPOLIS
LOS ANGELES OMAHA WICHITA

TEMPERATURE CONTROL IS OF FIRST IMPORTANCE IN MAKING TEMPERATURE-RESISTING ALLOYS



Approximately ten million dollars are invested in high-chromium steels alone by the process industries. The total cost of alloys now in use is enormous.

Tycos **Indicating Pyrometers are used extensively for accurate knowledge of furnace temperatures during the important process of alloy manufacture. Temperature control at this stage is imperative.** ***Tycos*** **accuracy contributes to the quality of the product.**

In case-hardening, annealing and all kinds of heat treating, ***Tycos*** **Automatic Temperature Control is recommended and** ***used.***

The other side of the story finds ***Tycos*** **Temperature and Pressure Instruments safeguarding those alloys by showing true conditions in operation.**

This one field is representative of ***Tycos*** **acceptance in every process industry.**

Tycos

Taylor Instrument Companies

ROCHESTER, N. Y., U. S. A.

Canadian Plant, ***Tycos*** **Building, Toronto, Canada**

New York	Philadelphia	Los Angeles	St. Louis	Detroit
Chicago	Pittsburgh	Indianapolis	Cincinnati	Atlanta
Boston	Cleveland	San Francisco	Tulsa	Minneapolis

Manufacturing Distributors in Great Britain: **Short & Mason Ltd., London**

Fractionating tower for an oil refinery loaded on cars ready for shipment from our Birmingham, Ala., plant. This tower is 11 ft. dia. and 87 ft. 3 in. long and weighs 230,000 lbs.

Center: Water separator drum 3 ft. 6 in. dia. by 8 ft. 10 in. long. Below: Show view of fractionating tower 8 ft. 4 in. dia. and 41 ft. 2 in. long.

B-191

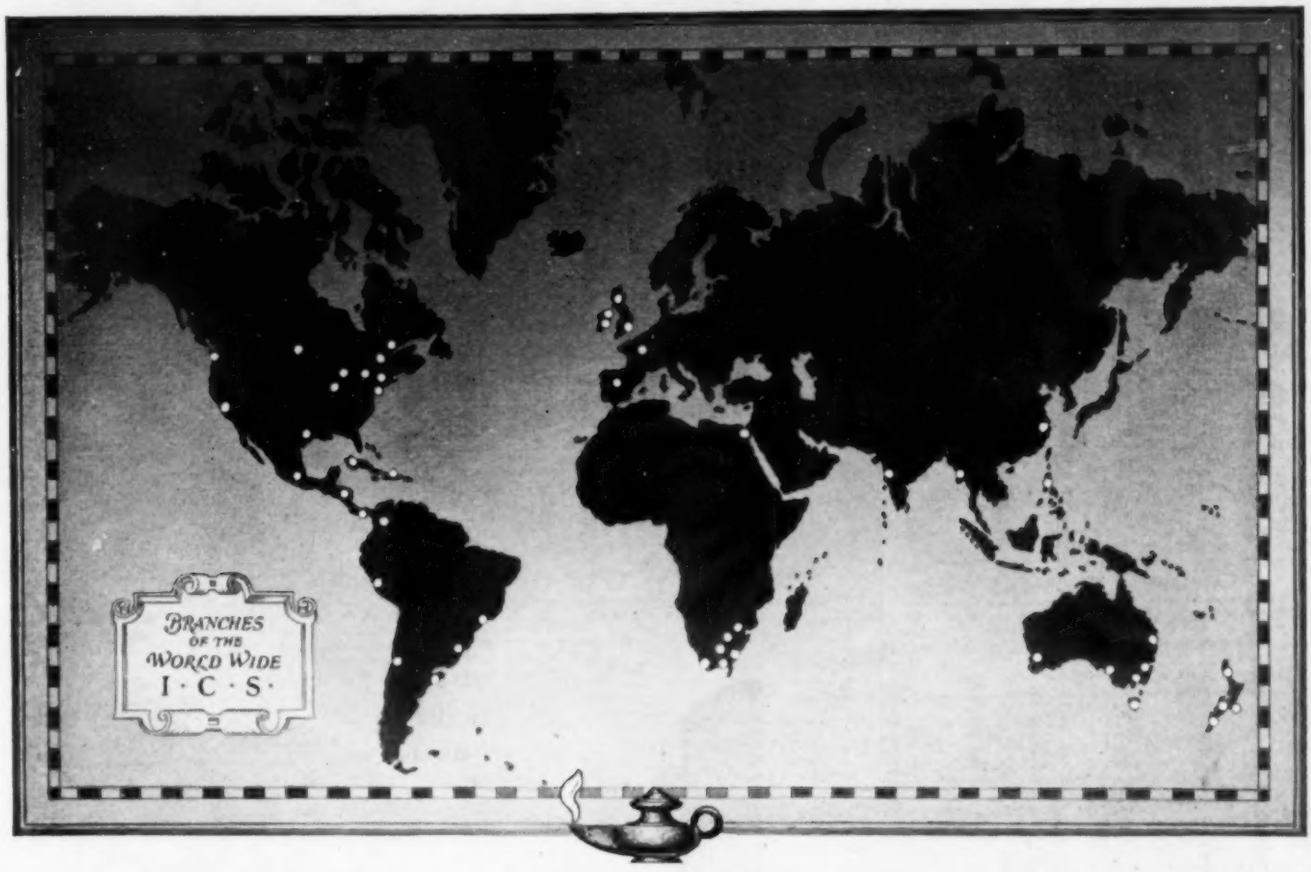
WE will appreciate the opportunity of quoting you our price on all steel tanks and steel plate work equipment you contemplate installing. We are equipped to fabricate special plate equipment to your designs or to prepare designs from your specifications. Strategically located fabrication facilities enable us to furnish this type of work promptly for any location. Address our nearest office.

CHICAGO BRIDGE AND IRON WORKS

Chicago.....2124 Old Colony Bldg.
New York.....3118 Hudson Terminal Bldg.
Cleveland.....2220 Midland Bank Bldg.
Dallas.....3305 Magnolia Bldg.
Birmingham.....1510 Fiftieth Street North
San Francisco.....1022 Rialto Bldg.

Plants at: CHICAGO, ILL.
GREENVILLE, PA.
BIRMINGHAM, ALA.

The EMPIRE of the LAMP



ALEXANDER dreamed of empire and conquered the Orient. Cæsar pushed his legions to the misty edge of the North, and claimed the world for Rome. The ships of Columbus cruised the coasts of unknown continents and Magellan carried his nation's flag around the globe.

But no empire of conquest or discovery has ever reached as vast an area of the earth's surface as the far-flung student organization of the International Correspondence Schools — the Empire of the Lamp.

Not only has this great institution extended its service to more than three and a quarter million students in the United States and Canada; in forty other countries, all over the world, more than half a million men have enrolled for home instruction with the I. C. S. It is said of the British Empire that the sun never sets on its dominions. And equally true is the statement that the study lamps of I. C. S. students are never dimmed. Somewhere they burn always, lighting the way to achievement.

In Shanghai a young Chinese bends above his engineering paper. "The supporting strength of a concrete beam . . ." he writes. And ten years hence he will be a builder of the new China.

In Melbourne a clerk is studying salesmanship, and in Madrid an importer is learning English. All up and down the world and on the high seas, through every hour of the twenty-four, men are at work beneath the lamp.

There are over 260,000 I. C. S. students in Great Britain and Ireland. Nearly 150,000 have joined the Schools in Latin America, and the number increases swiftly year by year. The little country of Colombia alone furnished a total of 1500 new enrolments in the year 1928.

Branch offices of the I. C. S. are maintained in many foreign capitals, and they have proved of great help to ambitious students. In the London Office alone, two hundred and fifty people are employed.

The International Correspondence Schools have more than justified their name. They have become a major influence in world affairs; a student brotherhood that knows no boundaries of race or flag. They present, today, an educational service as far-reaching as the mails, and as enduring as Man's desire for knowledge.

If you wish to know more about the work of the I. C. S., write for the booklet, "The Business of Building Men."

INTERNATIONAL CORRESPONDENCE SCHOOLS

FOUNDED 1891
SCRANTON, PENNSYLVANIA

MEMBER, NATIONAL
HOME STUDY COUNCIL

SEARCHLIGHT SECTION

EMPLOYMENT : BUSINESS : OPPORTUNITIES : EQUIPMENT—USED or SPECIAL

UNDISPLAYED—RATE PER WORD

Positions Wanted, 5 cents a word, minimum $1.00 an insertion, payable in advance.

Positions Vacant and all other classifications, excepting Equipment, 10 cents a word, minimum charge $2.00.

Proposals, 40 cents a line an insertion.

INFORMATION:

Box Numbers in care of our New York, Chicago or San Francisco offices count 10 words additional in undisplayed ads.

Discount of 10% if full payment is made in Advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH:

1 inch $6.00
2 to 3 inches..... 5.75 an inch
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Other spaces and contract rates on request.

An advertising inch is measured vertically on one column, 3 columns—30 inches—to a page. C.&M.

POSITIONS VACANT

ENGINEER, office assistant in new department of large corporation co-ordinating research with technical sales and service. Initiative, ability to use technical knowledge especially mathematics and physical chemistry as tool in new problems, and adaptability to varying demands of position essential requirements. Location west, salary moderate, ultimate prospects excellent. Desire man with research qualifications but preference and ability for commercial work. Give full details and recent photograph. P-705, Chemical and Metallurgical Engineering, 520 No. Michigan Ave., Chicago, Ill.

NEW organization requires part time services of research chemist, preferably Ph.D., with experience in alkali, cleaning material, or electro-plating field. State experience, present connections, time available, etc. P-704, Chemical and Metallurgical Engineering, 520 No. Michigan Ave., Chicago, Ill.

TINNING department foreman wanted. Man preferably about 35 years of age, with chemical experience. One who has had experience in pickling and tinning steel parts. Must have executive ability. Write Mr. C. Goebler, Supt., The De Laval Separator Co., Poughkeepsie, N. Y.

EMPLOYMENT AGENCY

AMERICAN Engineers Service, Harrisburg, Pa. Require for employment proposals qualifications data covering moderate salaried situations in research, analytical, physical, chemical development, operations, maintenance; steel sales.

When General Managers, Works Managers, Factory Managers, Industrial Engineers, Directors of Research, Chief Engineers, Comptrollers, Treasurers and other important men in the chemical industries can be better served in making new connections than they have been for twelve (12) years by us, this organization will be selected for the task. **Individual, Confidential.** The thousands of men of large earnings we have served and the business men they met and are happily associated with will say you can profitably entrust the job of finding your opportunity to us. NOT AN EMPLOYMENT AGENCY.

JACOB PENN, INC.

Established in 1919

535 Fifth Avenue, cor. 44th St., New York City

EMPLOYMENT SERVICE

IF you are qualified for position between $2,500 and $25,000, and are receptive to negotiations for new connection, your response to this announcement is invited. The undersigned provides a thoroughly organized service established twenty years ago, to conduct confidential preliminaries, and assist the qualified man in locating the particular position he desires. Not a registration bureau. Retaining fee protected by refund provision, as stipulated in our agreement. Send name and address only for description of service. R. W. Bixby, Inc. 700 Main Street, Buffalo, N. Y.

POSITION WANTED

ABLE chemical engineering executive, thirteen years' research and managerial experience: chemicals, electro-chemistry, electric-furnace, fur dyeing, technical sales; age 33, single. Capable of taking complete charge medium sized plant, desires managerial, executive or technical sales position. PW-702, Chemical and Metallurgical Engineering, Tenth Ave. at 36th St., New York.

CHEMICAL and metallurgical engineer, college graduate; four years' experience in roasting and sintering sulfide ores and operating acid plants off roaster and copper blast furnace gas. PW-706, Chemical and Metallurgical Engineering, 520 No. Michigan Ave., Chicago, Ill.

PRACTICAL young man, 22, with college training in the fundamentals of chemistry, chemical analysis and industrial chemistry, wants start in chemical plant or laboratory. Special interest electro-chemistry and hydrogenation of oils. Has ability and determination. PW-712, Chemical and Metallurgical Engineering, Tenth Ave. at 36th St., New York.

POSITIONS WANTED

CHEMICAL engineer, age 25, three years' diversified experience in development and research work. Employed, but desire change; prefer operating or development work with future. PW-707, Chemical and Metallurgical Engineering, Tenth Ave. at 36th St., New York.

CHEMIST, thoroughly experienced in the development and production of hot and cold molded plastic compositions, desires connection. PW-703, Chemical and Metallurgical Engineering, Tenth Ave. at 36th St., New York.

GERMAN, many years of experience in the metallurgical industry, especially experienced in the manufacture of oxide of antimony and zinc-white from metals and ores, as well as of oxide of zinc from metal and residues, desires suitable position. Address reply to V. Z., 2603 Rudolf Mosse, Inc., Graybar Bldg., New York City, New York.

PHOSPHATE chemical engineer, 11 years sodium phosphate, operating foreman, chief chemist, research, development. Record paying improvements. Intimate knowledge efficient plant operation. PW-708, Chemical and Metallurgical Engineering, Tenth Ave. at 36th St., New York.

PRODUCTION superintendent, brass ingot, metallurgist, many years' experience producing secondary metal alloys, available January, Middle West preferred. PW-704, Chemical and Metallurgical Engineering, Tenth Ave. at 36th St., New York.

SALESMAN WANTED

WANTED: Experienced salesman with a following in heavy chemicals and kindred line, basis commission and drawing account. Reply with full particulars to SW-710, Chemical and Metallurgical Engineering, Tenth Ave. at 36th St., New York.

POSITIONS OPEN

Manufacturing Executives, Chemical and Metallurgical Engineers; also Sales and Office Executives. Send for application—no advance charge whatsoever. Satisfaction guaranteed.

H. H. HARRISON, INC.

Personnel Counsellors Over 17 Years

20 W. Jackson Blvd., Chicago, Ill.

Patent Engineering Personnel

475 Fifth Ave., New York City

Advises, installs and supervises the work of corporation patent departments and supplies competent patent personnel for established corporation patent departments.

Within Three Months

Development Engineer—
Research Chemist

now in charge of major project

Can Be Available

Leading Interest :
Synthetic Decolorizing Earths

PW-711, Chemical & Metallurgical Engrg. Tenth Ave. at 36th St., New York City

WANTED

Chemical Engineer for SALES-Engineering

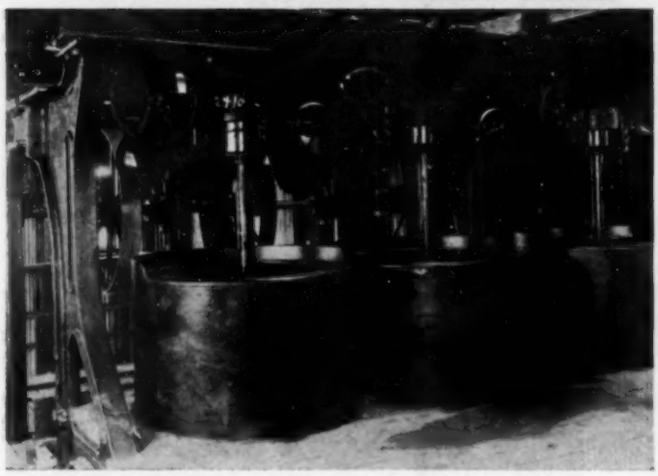
Young man with some experience in Research and Production, also with right qualifications for Sales-Engineering Department of Machinery manufacturer. Give full particulars regarding experience with Chemical or allied industries, references, salary expected, etc., when answering. Good opportunity with established Company.

P-701, Chem. & Met. Engrg., Tenth Ave. at 36th St., New York City

Business Opportunity
Books For Sale
Factory Location
Contract Work

Continued on Page 164

CENTRIFUGAL WRINGERS



BATTERY OF WESTON CENTRIFUGALS

1—Battery of two 40-in. American "Weston 1898" Centrifugal Wringers, steel baskets.
1—Battery of four 40-in. Tolhurst Centrifugal Wringers, steel frame, steel baskets.
1—Battery of three 36-in. Amer. "Weston 1898" Centrifugal Wringers.
1—Battery of three 40-in. Amer. "Weston 1898" Centrifugal Wringers.
2—American 42-in. Nitrating Wringers, complete.

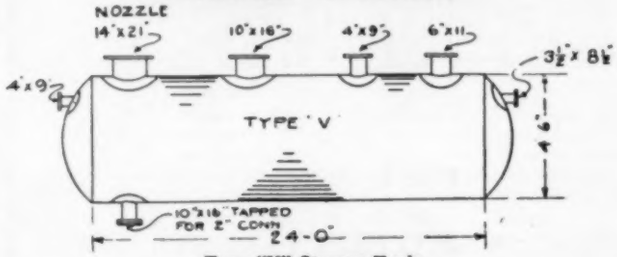
The above wringers are in especially good condition, all complete and ready to run. One of the best stocks of wringers on the present market.

A FEW GOOD SPECIALS

12—Buffalo Reducers.
3—300 gal. Autoclaves.
2—400 gal. Acid Eggs.
6—900 gal. Iron Pots.
1—H & B Disintegrator.
1—Benzol Still complete.
3—12,000 sq.ft. Condensers.
2—350 sq.ft. Condensers.
1—48-in. all Iron Column.
1—Beta-Naptha Still.
2—Briquette Presses.
3—Williams Crushers.

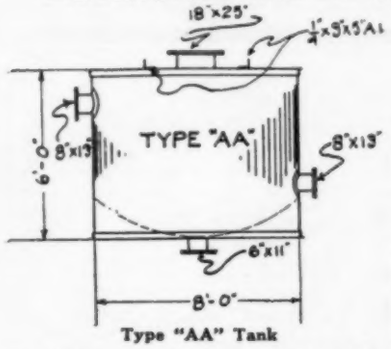
SPECIFICATIONS SENT ON REQUEST

STEEL TANKS



Type "V" Storage Tank

15—Steel Tanks, Type "V"; circulating or storage Tanks for acid; 4-ft. 6-in. diameter x 24-ft. long; capacity 2900 gallons; ½-in. steel plate; 80 lbs. pressure. Can be furnished with 3-in. submerged type pumps if desired. Part were installed but never used.

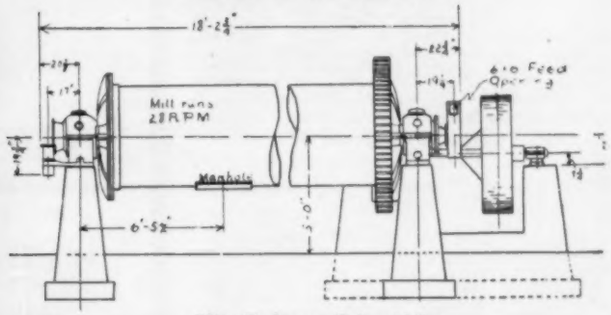


Type "AA" Tank

40—Steel Tanks; Type "AA"; Pressure Filters or Storage Tanks; 8-ft. diameter by 6-ft. high; capacity 2300 gallons; ⅜-in. plate; 40 lbs. pressure. Were installed but never used. Covers are bolted to angle rim. These are good tanks for storage or mixing and have supports for false bottom, if desired.

TRY OLD HICKORY FIRST

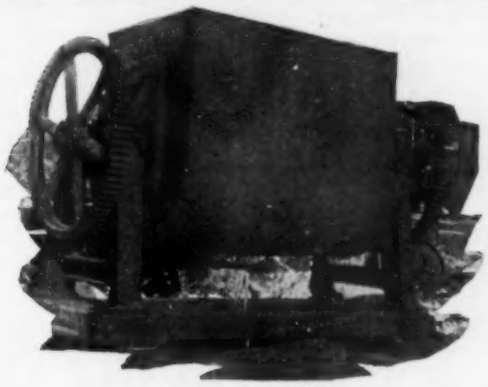
TUBE MILLS



Allis-Chalmers Tube Mill

1—Allis-Chalmers 4-ft.6-in.x12-ft. Tube Mill; Silex lining; complete with jack shaft and scoop feed.
1—Smidth "Davidsen" Tube Mill 4-ft.x16-ft.; Silex lining; complete with jack shaft and screw feed.
1—Kennedy-Van Saun 8-ft.x6-ft. Ball mill; steel lining; complete with jack shaft and motor.
1—Standard 4-ft.x3-ft. Ball Mill; steel lining; complete with jack shaft and scoop feed.

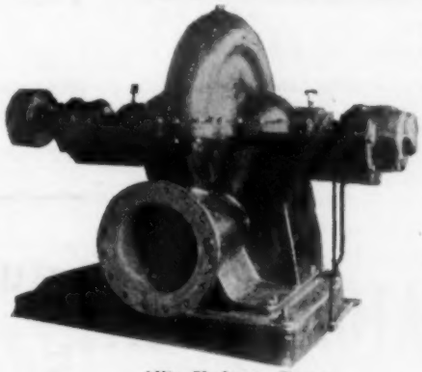
GRAINERS AND MIXERS



Stokes Grainer or Mixer

3—Stokes Jacketed Grainers or Mixers; 300 gallon capacity; cast iron body 5-ft.x3-ft.x4-ft.; steel blades; steel jacket; tilt arrangement for dumping.

CENTRIFUGAL PUMPS



Allis-Chalmers Pump

1—10-in. Lawrence Belted Centrifugal Pump.
2— 8-in. Lawrence Belted Centrifugal Pumps.
2— 6-in. Lawrence Belted Centrifugal Pumps.
3— 6-in. Baker Belted Centrifugal Pumps.
2— 5-in. American Belted Centrifugal Pumps.
2— 4-in. Lawrence Belted Centrifugal Pumps.

2—14-in. Allis-Chalmers Pumps; 6500 G.P.M.
5—16-in. Allis-Chalmers Pumps; 8500 G.P.M.
7—14-in. Worthington Pumps; 8500 G.P.M.
1—10-in. Goulds Pump; 2500 G.P.M.
1—8-in. Goulds Pump; 2000 G.P.M.
1—8-in. Goulds Pump; 1500 G.P.M.
1—8-in. Goulds Pump; 2500 G.P.M.
2—5-in. Goulds Pumps; 800 G.P.M.
2—4-in. Goulds Pumps; 550 G.P.M.
1—4-in. Goulds 2-stage Pump; 800 G.P.M.

All above pumps are direct connected.

TRY OLD HICKORY FIRST

Many other sizes always in stock

The Articles Listed Above Are Only a Few of Our Immense Stock. What Do You Need? We Probably Have It. Wire, Phone or Write Us.

NASHVILLE INDUSTRIAL CORP.

OLD HICKORY — AFFILIATED WITH THE MORSE BROS. MACHINERY AND SUPPLY CO., DENVER, COLO. — TENNESSEE

SEARCHLIGHT SECTION

BUSINESS OPPORTUNITIES

Continued from page 160

Active Partnership

In established chemical or kindred business desired; 19 years' chemical, executive, business experience; modern investment; references. BO-709, Chemical and Metallurgical Engineering, Tenth Ave. at 36th Street, New York.

FREE BULLETIN

CONSOLIDATED Products Co., Inc., 15 Park Row, New York, N. Y. Bulletin No. 11, 4-page, 8½x15, listing used crushing, pulverizing, filtering, drying and other equipment available from stock. Classified and with illustrations. Also special bulletin of used Raymond and other mills.

LAKESIDE Machinery Company, 567 West Lake St., Chicago, Ill. List No. 70, 12 pages, 4x9, classified. Items listed include construction, mining, process, power and shop equipment.

THE "Emerman Red Book"—No. 30—covering stock of used and new machinery, tools and supplies—just issued. Lists, with prices, over 275 varieties machine tools, shop and plant equipment, classified, illustrated and indexed: 260 pages, 4x9, with stiff board cover; suitable for reference file. Write Louis E. Emerman & Co., 1761 Elston Ave., Chicago, Ill.

Chemical Research Periodicals
BOUGHT AND SOLD

Back issues of Chemical & Metallurgical Engineering and other Chemical and Scientific Magazines, as well as complete files in stock.

B. LOGIN & SON, Inc., 29 E. 21st St., N. Y.

WANTED

WE WANT YOUR
PLATINUM SCRAP
IN ANY FORM

We pay highest market price, make prompt returns and hold goods for your approval.

I. MILLER, Smelter and Refiner
252 Colonial Arcade, Cleveland, Ohio

WANTED
AIR SEPARATOR

Gayco or Sturtevant Selector Type. Give size, model, present location and price.

W-699, Chemical and Metallurgical Engrg.
Tenth Ave. at 36th St., New York City.

—WANTED—

EVAPORATORS

SINGLE—DOUBLE

or

TRIPLE EFFECT

Cast Iron Bodies—Copper or Brass Tubes—1500-3000 Square Ft. — Barometric Condensers —

W-700, Chem. & Met. Engrg.
Guardian Bldg., Cleveland, Ohio

DRYERS

E-15 Buffalo, 15 shelf 42x42 in.
F-20 Buffalo, 20 shelf 42x42 in.
No. 12 Devine, 20 shelf 40x43 in.
2x4, 2x6 and 2½x8 Rotary Vacuum.

FILTERS AND FILTER PRESSES

18-in. Johnson, 24 plates and frames.
24-in. Sperry, 25 plates and frames.
24-in. Sperry, 30 recessed plates.
No. 7 Sweetland, 27 iron leaves.
6x6 and 6x4 Oliver, continuous.

KETTLES

40 and 60 gal. Aluminum, jacketed.
20 to 200 gal. Copper, jacketed.
60 gal. Pfaudler, jacketed, agitated.
150 and 200 gal. Dopp, jacketed.

TANKS (Glass Lined)

400 gal. Glasscote, jacketed, 48x54 in.
500 gal. Elyria, jacketed, 48x66 in.
6—1250 gal. Pfaudler, 54x126 in.
1250 gal. Pfaudler, Vertical, 72x84 in. with side agitator.

VACUUM PUMPS

4x6 Devine, belt driven.
6x6 Buffalo, belt driven.
7x8½x7 Buffalo, steam driven.
7x8½x8½x7 Buffalo, steam driven.
5x6x10 National, wet vacuum.

MIXERS

¼, 1/3 and 1 hp. Portable Type.
9 gal. W. & P. Class BB, Type II.
80 gal. Day "Brighton", change can.
200 gal. Faust, jacketed, heavy duty.
100, 200, 800 and 1,600 lb. Day.
W. & P. 100 to 2650 gal. capacities.

STILLS

3x3-ft. Copper with 10 in. x 8 ft. column, condenser and dephlegmator.
26x50-in. Copper vacuum with condenser.
40x72 in. Copper vacuum with condenser and vacuum pump.

We are always in the market to buy. Send us your list of surplus equipment.

SPECIAL OFFERINGS

520 gal. Devine Steel Jacketed Kettle, bolted tight cover, 3/16 in. copper lining, agitator with worm drive and 2 H.P. motor.

800 gal. Devine Steam Jacketed Kettle, 3/16 in. copper lining, draft tube, agitator with worm drive and 5 H.P. motor.

This is only a partial list.

Send your inquiries for anything you need.

ROBERT P. KEHOE MACHINERY CO.

51 East 42nd St., New York, N. Y. Telephone— Vanderbilt 9594 9595 9596
Main Warehouse and Yard, 730-736 East 141st St.

Manufacturers

You are invited to utilize our industrial and engineering services on factory establishment or relocation. Complete reports on industrial advantages in areas served by our properties. . . . All negotiations confidential and gratis. Address Industrial Development Department.

ASSOCIATED GAS AND ELECTRIC SYSTEM

61 Broadway — New York City

Special Heavy Machinery

Three plants (one at Harvey, Ill. and two at Birmingham, Ala.) equipped for handling large work of any kind, particularly for utility plants and large construction projects. Machine facilities include:

Boring Mills up to 28-ft. dia.
Planers up to 148-in. wide, 30-ft. long.
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Drills—unlimited capacity

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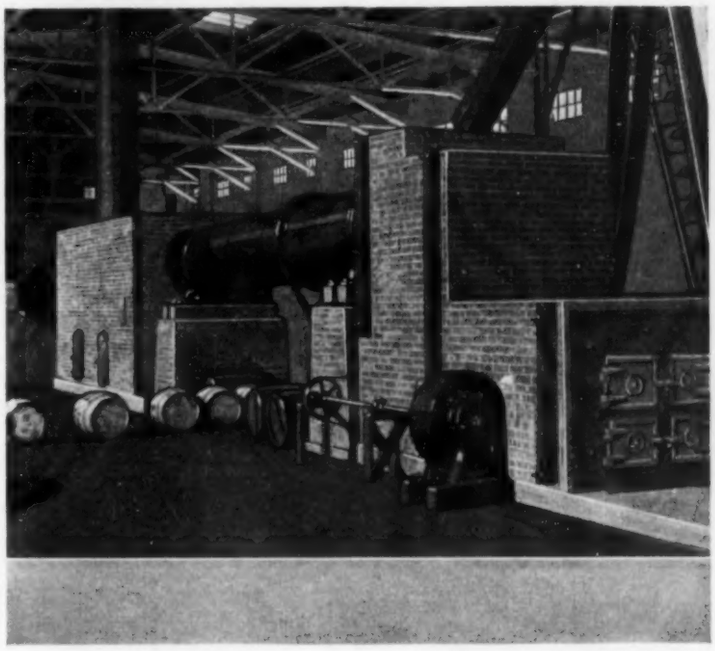

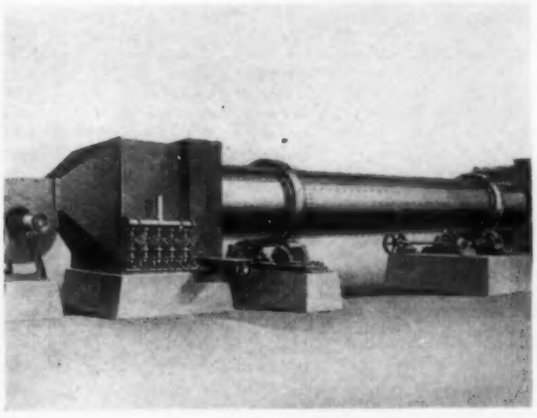

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Figure 297 K-N
Flanged Straightway Design

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Figure No. 293 K-N
Acid Proof Knight-Nordstrom Lubricated Valve, Plain Bib Design.

Figure No. 298
Acid Proof Block Cock

Solutions which constantly tend to make the ordinary Valve stick can be easily and conveniently handled with the KNIGHT-NORDSTROM LUBRICATED ACID PROOF STONEWARE VALVE, since its patented feature permits a sure means of the lubricant reaching the plug and all bearing surfaces.

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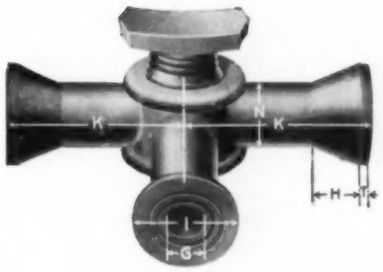

Figure 303
Acid Proof Conical Flanged Three-way Valve

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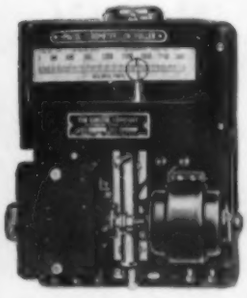

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